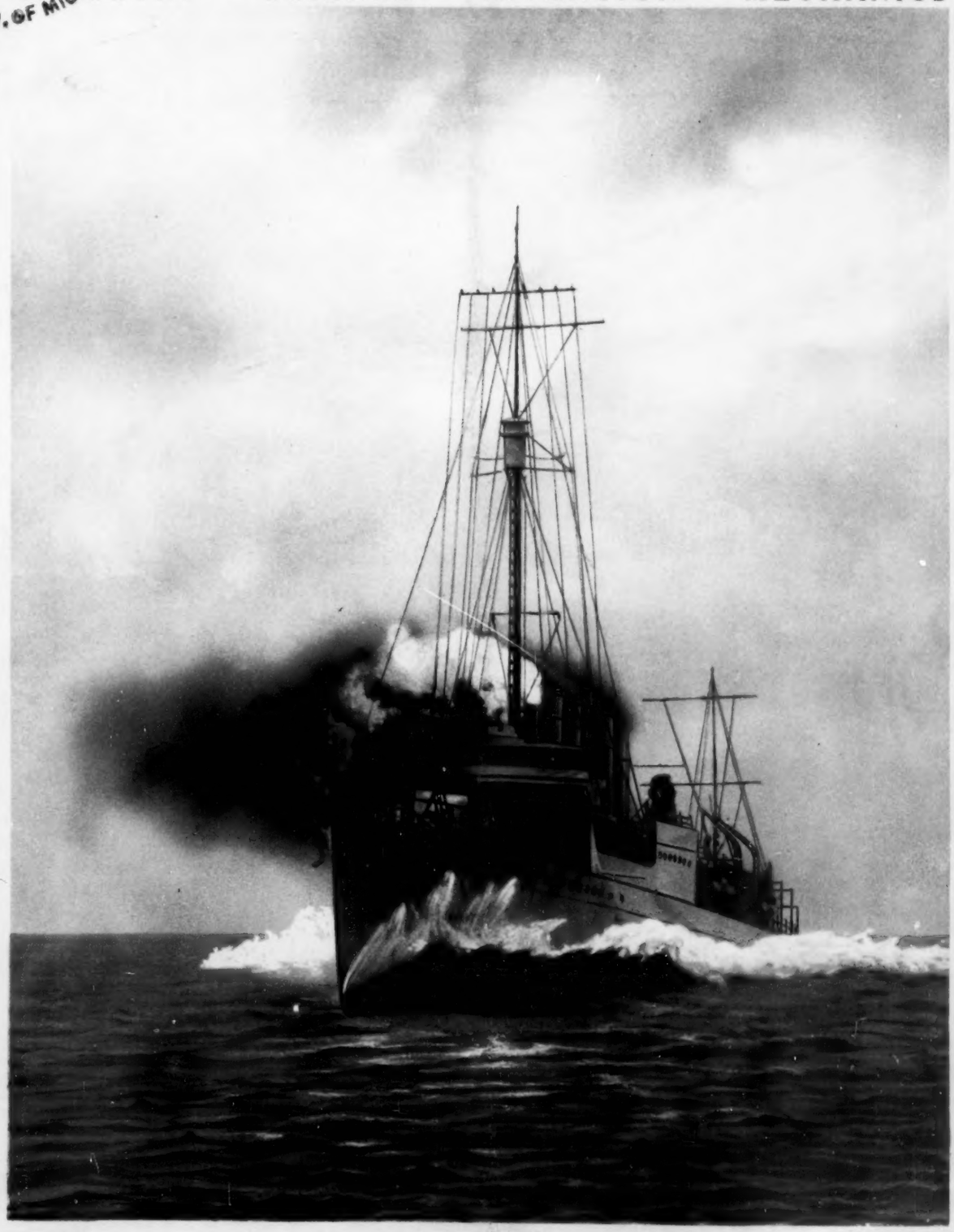
IN THIS ISSUE:

LEADING NAVIES COMPARED
HOW WE THINK

SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



ONE OF THE LATEST U. S. DESTROYERS AT FULL SPEED

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are three arches. It is the first of its kind ever constructed. The central arch has a span of 70 feet and the side ones a span of 25 feet each. This dam closes an opening of 125 feet wide. There are only 184 cubic yards of concrete in the structure.

Scientific American Monthly for February

(*Continued from page 109*)

tecture illustrating his story with photographs taken by himself.

What is the place of life in nature? How is this peculiar and special development which we describe as living to be derived from a cosmos which close observation shows to be subject everywhere to rigid determination by mechanical and mathematical laws? The question is asked by Dr. Ralph S. Little, who proceeds to discuss the problem in an able article.

Owing to the phenomenal demands for furs in recent years there has been a greater temptation than ever to substitute inferior furs for the more valuable ones by clipping, dyeing or pulling them, thus the appearance of the furs are so altered that it is difficult for anyone but an expert to distinguish the genuine from the imitations. An article by Dr. Leon Augustus Hausman deals with this subject and shows how the microscope enables us to distinguish the various furs.

"Indian Uses of Kelp" is the title of an interesting article by J. C. Leachman, in which he tells of various articles made by North American Indians out of different kinds of sea weed. These include fishing lines, bottles, and even toys, sections of stem being used to make the wheels of toy wagons. Sea weeds were also used in ceremonials and as amulets. Unfortunately, owing to the perishable nature of the materials, many examples of the use of kelp have been lost, but enough have been preserved to illustrate the value of marine vegetation to these primitive peoples.

With the all-seeing eye of the Roentgen ray experts are now examining old paintings to determine whether they are genuine. It has been found that the pigments used in previous centuries are much more opaque to X-rays than are modern paints made of aniline and vegetable dyes. The antiquity of paintings can therefore be determined by noting their opacity to the X-rays. The process is described in the February Monthly and is illustrated with some very interesting photographs and radiographs.

The February issue contains the usual departments of notes on various branches of technology and scientific research with the exception of the department conducted by the National Research Council, which is omitted this month, but will appear in the March issue.

The Heavens in February, 1921

(*Continued from page 112*)

Capella is high in the northwest, with Perseus below, and Andromeda setting. Cassiopeia, Cepheus and Draco are low on the northern horizon. The Little Bear is above the last two, and the Great Bear much higher, in the northeast.

Arcturus has just risen, north of east, and Spica is rising farther to the southward. Leo is well up in the east, and Hydra stretches from the southeastern horizon almost up to Procyon. A number of the bright stars belonging to the constellation Argo may be seen low on the southern horizon, but they are not conspicuous, as they are in southern latitudes; and the brilliant region of the Milky Way (which surrounds them is hardly visible to us at all.

The Planets

Mercury is an evening star throughout February. He reaches his greatest elongation or apparent distance east of the sun upon the 15th. At this time he is almost exactly in perihelion and his apparent distance from the sun is therefore unusually small, 18° 8′; but to compensate for this he is more than 7° farther north than the sun, and is therefore easily visible, setting at 7 P. M. He is brighter than any of the stars except Sirius, and should be conspicuous in the twilight. By the end of the month he gets very near the sun, and is lost to sight.

Venus is likewise an evening star, and she also reaches her greatest elongation during the month—on the 10th—at a distance of 46° 46′. Being farther north than Mercury, as well as farther from the sun, she remains visible until 9:20 P. M. Telescopically she looks exactly like a half-moon, though of only one-eightieth the apparent size.

Mars, too, is in the evening sky, between Mercury and Venus, but only half as far from the latter as from the former, and remains in sight until after 8 P. M. He is about 200 million miles from the earth, and is correspondingly faint.

Jupiter is in the eastern part of Leo, and rises a little after 7 P. M. in the middle of the month, so that he is well placed for observation before midnight. Saturn is on the western edge of Virgo and about seven degrees east of Jupiter, rising approximately half an hour later. He is a telescopic object of extreme interest, for his rings are turned almost edgewise toward the earth. During most of the month their plane passes between the earth and the sun, and only the dark side is visible, so that with all but the greatest telescopes the planet appears merely as a disk, while with very powerful instruments the rings may be faintly seen illuminated by the light reflected from the planet, together with that which filters through from the sunlit side between the fine particles of which the rings are composed. On the 22nd the rings are turned exactly edgewise toward the earth, and (as previous observations at this phase have shown) they will be wholly invisible in even the greatest instruments. Then for about seven weeks we will see the sunlit side of the rings, very nearly edgewise, as a thin spike of light projecting from each side of the planet.

Uranus is in Aquarius, still an evening star, but too low to be observed. On the 24th he passes behind the sun and becomes a morning star. Neptune is in Cancer and comes to opposition on the 1st. At that time he is in 8h. 5m. 26s. R A and 17° 8′ north declination. He moves slowly westward, and on the 27th is in 8h. 56m. 39s., 17° 20′ north. Observers with equatorially mounted telescopes may find him along the line thus indicated; but a fairly large aperture will be required to show the planet's disk.

The moon is new at 5:37 P. M. on the 7th, in her first quarter at 1:53 P. M. on the 15th, and full at 11:32 A. M. on the 22nd. As this calendar month is shorter than the lunation, the moon does not pass through her last quarter in February at all. She is nearest the earth on the 20th, and remotest on the 5th. While making the circuit of the sky she passes close to Uranus and Mercury on the 9th, Mars early on the morning of the 11th and Venus on the same evening, Neptune on the 20th, and Jupiter and Saturn on the 23rd. The conjunction with Venus is close, and an occultation is visible in Asia; but we are unfortunately on the wrong side of the earth and will see nothing of this.

Skjellerup's Comet

An orbit of this comet has been computed at the University of California from observations covering an interval of nearly three weeks, and should be very near the truth. According to this the comet passed perihelion on December 11, at a distance of one hundred and thirty million miles from the sun. Its orbit is inclined 22° to the ecliptic, and it passed through the ascending node about two weeks after the perihelion. It is now slowly receding from the sun and more rapidly from the earth and growing steadily fainter, and there is no chance that it will ever become conspicuous.

SEVENTY-SEVENTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

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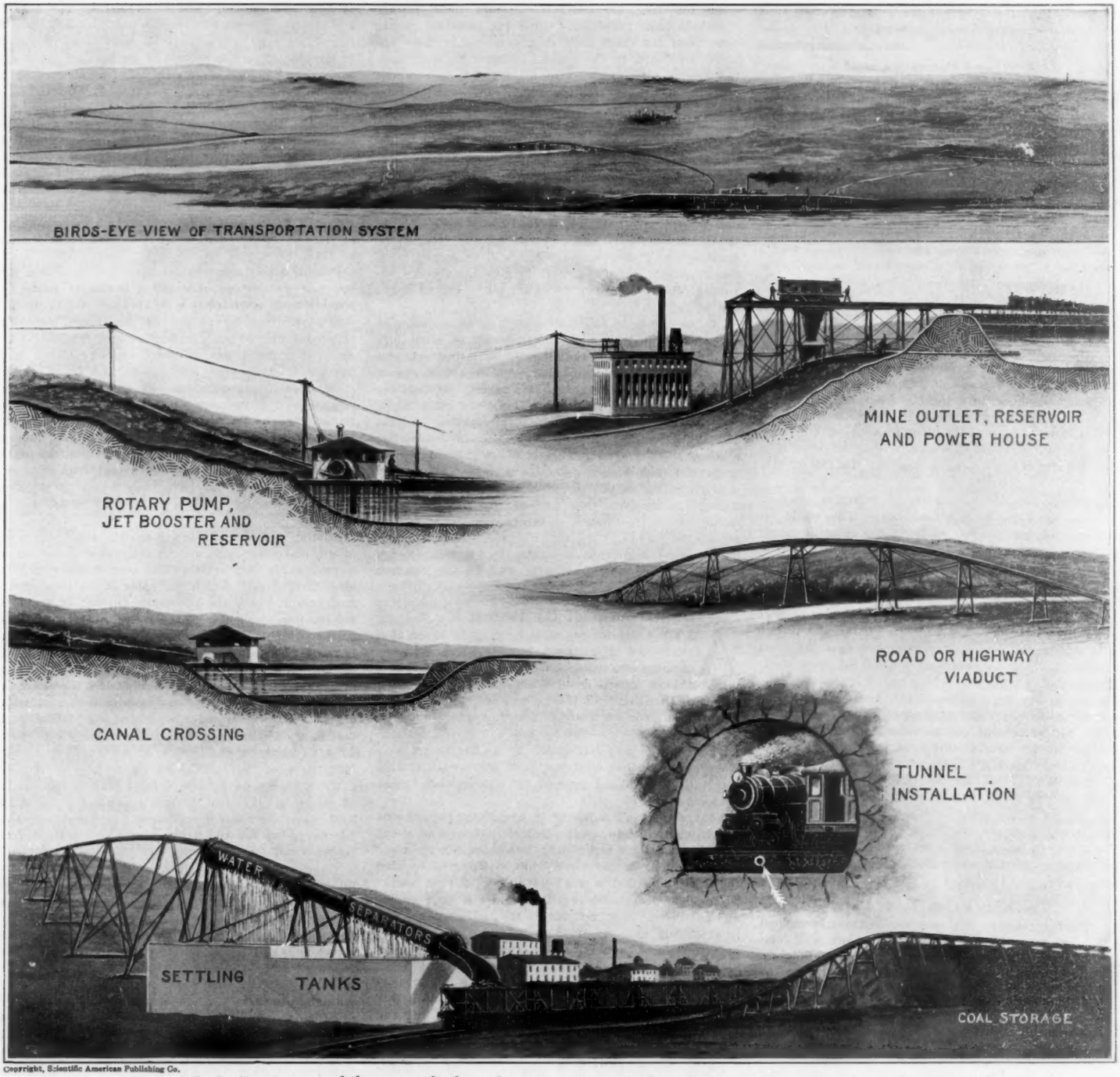

Some of the leading features of the proposed scheme for transporting coal through pipes under water pressure (See page 126)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

A Second Panama Canal

SECRETARY OF WAR BAKER is reported to have stated that he would favor the construction of a second Isthmian canal, either paralleling the Panama Canal or cutting through Nicaragua. No doubt the day will come when the proposition of enlarged accommodations will have to be faced; though it cannot be said that the present canal has by any means reached the limit of its capacity. Nevertheless, prudence suggests that we should look ahead and be prepared for this contingency. There are only three possible methods by which enlarged ocean traffic across the Isthmus can be accomplished, namely, by a new canal through Nicaragua, by a new canal near Darien, or by widening the present canal. A canal at Nicaragua would involve large and difficult dam construction and enormous retaining walls along the sides of the valleys through which the prism would have to be built. To say nothing of the risk of earthquake shocks, its cost would be prohibitive. A canal at Darien would involve the construction of a tunnel 150 feet wide, and at least as high, through the mountain divide. The risk of displacement of the roof through earthquake shock would be so great, even if it were heavily concreted, as to prohibit the use of this route.

There remains the alternative of enlarging, and, if possible, doubling the existing canal. This could be done by building two sets of locks adjoining the present locks, provided suitable rock foundation could be found at the various sites or some method of massive concrete pile supports were found to be practicable. For the first few years the existing prism might prove to be of ample capacity; but ultimately it would be necessary to widen the canal throughout. In the Gatun Lake this would be a matter of simple dredging; but it would involve an enormous amount of rock work through the Culebra Cut, which would be followed inevitably by the old trouble of heavy slides, until the material found its natural angle of repose. The task would not be beyond the resources of modern engineering, but in view of increased labor and material costs the enlargement would call for capital approaching that which was necessary for the construction of the existing canal. The determining question, however, in the enlargement of the canal would be the summit water supply, and it is doubtful whether the flow of the Chagres River would suffice for more than the addition of one single lock adjacent to the existing locks.

The King's Cup Ocean Race

NOT for many years past has anything been done to promote deep-sea yachting that will compare with the offer by King Albert of Belgium of a gold cup for an ocean race from Sandy Hook to Ostend. The fleet of yachts which will start from the Ambrose Lightship on the morning of July 4th next will cross the finish line at Ostend in the height of the season at that now historic watering place—historic because here was fought one of the most heroic naval contests of the war. Ostend, which for over four years bristled with seacoast guns and resounded with the crash of heavy artillery, will be her old self next July, when the white-winged racing yachts sail into harbor, through channels which so long were shut in by the deadly mine field and by warships, sinister in their dark gray paint. They will be welcomed by pleasure-loving throngs upon those very piers and esplanades which so lately were disfigured by the gray-coated soldiers of an invading army.

It was fifteen years ago that another fleet of ocean-going yachts sailed a transatlantic race for the once-famous Kaiser's gold cup, which, by the way, on being sold for war or charitable purposes, turned out to be of gold-plated pewter. We may be sure that there will be no pewter in King Albert's Cup. It will be pure gold, like the gallant King himself, than whom no outstanding personage of the war has come through with greater honor, respect and love of the peoples of the world. The Kaiser's Cup was won by William Gardner's design, the famous three-masted schooner, "Atlantic." She still sails the sea, but under a greatly reduced rig, her lower masts having been cut down some ten feet, we understand, from their former length—a huge reduction. Other big and fast yachts have been launched since that date and will be entered, no doubt, in the contest. There is the Herreshoff-designed "Elfay," a two-masted schooner whose rig also has been greatly reduced for cruising purposes; and there is the "Undaunted," a three-masted schooner designed by Wells, whose huge sailspread has not, we believe, suffered the clipping to which her probable competitors have been subjected. Whether the owners of some of these and many other big craft will feel disposed to go to the expense of resparring and recanvasing their yachts or no has yet to be determined. We rather expect to see it done; for as the entries multiply and the time for the great event drawns near, the sporting spirit will be strong upon the owners of these big craft to give them every advantage that racing canvas and trained racing crews can bring.

The race is to be sailed without time allowance, and the start will be made independently of wind and weather, which means that it is to be a thorough seagoing test. Other things being equal, the race should be to the strong—that is to say, in this case, to the big ship; for length means speed. On the other hand, July is apt to provide a considerable portion of light airs and head winds, in which case some of the smaller schooners and single-stick craft of purely racing model may push their bigger sisters to a close finish. That staunch racing cutter, the 23-meter "Shamrock," is in winter quarters on this side of the water, and it would add to the interest of the race if she should be among the yachts at the starting line. Since she was built under the international rule, the yacht is staunch enough to face a transatlantic race in the summer season.

Disarmament of the British Navy

ALTHOUGH we are most heartily in favor of a universal reduction of naval and military armaments, we deplore the fact that there has been, and is today, much confused and misleading speech and writing upon this momentous subject. Some of this confusion of thought is unintentional and due to lack of knowledge—but too much of it is intentionally misleading and deliberate. If we are to get anywhere in this discussion, we must start with clearly ascertained facts and proceed by sincere and logical reasoning.

That very small minority in our Navy Department which would like to see the United States spend about one billion dollars in building "incomparably the most powerful fleet in the world" has endeavored to give the impression that a great naval shipbuilding competition is in progress between the other leading navies and ourselves. Now, as regards the British navy, this is absolutely untrue. If there be any naval race, we have the course entirely to ourselves, for Great Britain is doing no new shipbuilding whatsoever, and relatively to our own fleet, that of Great Britain is not so powerful as it was before the war. To be clear upon this point, let us consider the past seven years, and the losses of the British by war and by the breaking up and sale of ships since the armistice.

During the war Great Britain lost out of her fighting fleet over 600,000 tons or two-thirds as much tonnage as there was in the United States fleet in 1914. The facts regarding this tremendous depletion of her navy are to be found in a pamphlet published by our Office of Naval Intelligence, entitled "Information Concerning the United States Navy and Other Navies." From this we learn that her losses by mine, submarine, shell fire and other causes were as follows: three battle-cruisers, including the super-battle-cruiser "Queen Mary" (63,000 tons); 13 battleships, including the 23,000-ton dreadnaught "Audacious," and the 19,250-ton dreadnaught, "Vanguard" (201,000 tons); 10 armored cruisers (151,000 tons); 9 light cruisers (51,500 tons); 6 monitors (8,125 tons); 67 destroyers (50,500 tons); 52 submarines (37,000 tons); and 22 sloops (26,000 tons). The total, including other smaller craft, is over 600,000 tons. Added to these was a loss of 37 merchant auxiliaries, including many ships of from 12,000 to 18,000 tons, which brings the total loss to nearly three quarters of a million tons.

To make good these losses and to keep pace with the demands of the war, she took in hand a large program of new construction. But when victory was assured and the world-menace of the German fleet had been removed, all outstanding contracts were canceled, except in the case of certain vessels of the smaller types that were near completion; and a large number of ships, including three sister ships to the 42,000-ton battle-cruiser "Hood," were broken up on the stocks and sold as junk. These facts cannot be too strongly stressed, in view of the impression which has been conveyed by Senator Reed, Senator Phelan and other well-known politicians of their school, that Great Britain is still surging ahead with a vast program of naval expansion. As a matter of fact, it is some seven and a half years since the British Admiralty laid down a battleship, and of light craft not one has been ordered since the fall of 1918.

Furthermore, in agreement with her conviction that the war was indeed over and a period of peace and reduction of armaments was at hand, Great Britain struck off from her active list practically the whole of her big fleet of pre-war dreadnaught battleships, her armored cruisers, her protected cruisers and a large number of destroyers, submarines and other smaller craft, the list totaling about 150 ships that were either retired, sold or broken up. Not only this but she has tentatively condemned all of her capital ships that are armed with guns of 12-inch caliber or less; and although she has still on the list 26 dreadnaught battleships, several of these that are armed with a 12-inch gun are in reserve, or have been delegated to minor duties as practice ships, gun training ships, and so forth.

Another point which is perhaps the most significant of all, and one which will be fully appreciated by all naval men, is that in her whole fleet there is only one ship, the "Hood," which embodies in its construction and arrangements the enormous amount of technical information gleaned from the Battle of Jutland, information which was loyally passed on to the experts of her ally, the United States. Had she gone ahead with her program as we have done, she would today have in her fleet three additional ships of the "Hood" class; her fleet of light cruisers would have been greatly increased; and she would have added over 100 ships to her fleet of destroyers and submarines, all of these vessels embodying the lessons of the war and particularly those of the Jutland engagement.

We think we have made it clear that in this matter of disarmament, Great Britain has already taken the lead, since she has not only greatly reduced her existing navy, but for two years past has refrained from laying down any new warships. Here was a lead in naval disarmament which we might very well have followed, and those of us who are keeping our heads clear of international suspicions and hatreds, and are looking at facts as they are, must feel that there is no little truth in the following statement of the British Naval and Military Record: "Had the United States followed our lead in effecting such sweeping reductions in naval material, the world would not now be faced with the prospect of a new era of naval rivalry. It is practically certain that but for the American decision to complete not merely all the vessels authorized by the 1916 program, but nearly all the destroyers, submarines, et cetera, ordered under the emergency war programs, Japan would not have introduced her 1920-1928 Navy Bill, thus giving a new and powerful impetus to international competition."

Electricity

Portable Phase-Sequence Indicator. — To enable phase sequence to be determined easily an American manufacturer is placing on the market a light and compact indicating device. It is so designed that when the phases of a circuit are connected to the binding posts a pilot lamp set into a recess in the case indicates by its brightness or dimness the direction of phase rotation. A push button in the case reverses two of the leads and provides the contrasting indications of the lamp by modifying the magnetic flux resultant of the interior coil windings. The device has no moving parts and weighs less than three pounds.

Electric vs. Fuel-Fired Furnaces.—The pronounced advantages of the electric furnace in providing easy and positive temperature control and uniform heat distribution are held to account for a large number of these furnaces that have been placed in service during the last few years, according to *General Electric Review*. It is said that nearly all the brass-melting furnaces now being installed are electric furnaces. While in many cases the electric furnace has been selected on the basis of performance rather than on cost of operation, the rising cost of fuel and even the cost of operation may be decidedly in its favor.

Remote-Control Panel for Radio Stations. — An American builder of radio equipment has scored a distinct forward step in a highly convenient form of remote-control panel which is destined to save much time and labor in the operation of radio sets of substantial size. The panel, which can be mounted on a desk or table so that its two keys are flush with the top of the desk or table, is intended to govern the important circuit adjustments at a distance from the main apparatus assembly. This equipment is being marketed for 2 kilowatt sets, is being built for 5 kilowatt sets, and may be built soon for units up to 30 kilowatt rating.

The Variation of Thermal Conductivity during the fusion of metals is discussed in a recent issue of the *Philosophical Magazine*. The results of a long investigation are summarized as follows: (1) The thermal conductivity of tin, lead, zinc, and aluminum decrease with the rise of temperature up to their melting point. (2) For these metals thermal conductivity decreases abruptly during melting. (3) The thermal conductivity of bismuth and antimony slightly decreases at first and then increases a little. (4) During melting the conductivity of bismuth considerably increases, and that of antimony seems to increase only slightly. (5) The thermal conductivity of all liquid metals here investigated decreases but slightly with the rise of temperature. (6) The above changes of thermal conductivity are similar to those of electric conductivity for the same metals.

Canada — Second in Developed Water Power. — According to a recent study of water power resources of different countries, Canada has the greatest per capita water power development of any country in the world excepting Norway. This development is 0.26 horsepower per capita, while that of Norway is 0.54 horsepower, and of the United States is 0.07 horsepower, according to *Electrical Review*. The United States, with 30,000,000 horsepower available, leads the world in potential and developed water power resources, Canada ranking second. In general, Canadian water powers are applied to three uses: (a) Municipal purposes; (b) for manufacture of pulp and paper; and (c) for electrochemical and similar processes. Of the developed water power about 78 per cent is used for municipal purposes, about 14 per cent for the pulp and paper business, and about 8 per cent for electrochemical or similar processes.

The Largest Submarine Cable in the world, so it is believed, was recently opened for traffic when direct telephone communication was established between East Prussia and Germany over a 160-kilometer (100-mile) cable in the Baltic. This telephone connection, according to *Electrical World*, must go over a roundabout route in order to comply with certain regulations in the Versailles peace treaty concerning the "open road" from Poland to the Baltic. The cable contains six pairs of "krarupized" telephone conductors and three single conductors for telegraphic purposes. The cable has a paper-strip insulation close to the wires and then a lead cover reinforced by a double helix of steel wire with a ¾-inch pitch. The outside covering is made of jute and compound and is protected by a 0.2-inch armor made up of twenty-nine galvanized wires of steel with S-section. The outside diameter of the cable is 2 inches, and the weight is about 11 tons per kilometer (18 tons per mile).

Science

Captain Robert A. Bartlett, who made several Arctic expeditions with Admiral Peary, is trying to raise money to finance an expedition across the North Pole in an airplane. If the sum of $300,000 is raised the expedition will probably take place.

Meeting of German Scientists.—The German equivalent of the British and American Associations for the Advancement of Science—the Gesellschaft deutscher Naturforscher und Aerzte—recently held its first meeting in seven years, at Bad Neuheim, with an attendance of 2,600 members.

Abraham's Wells, Beersheba, Palestine are now equipped with modern pumping machinery and are supplying water to the town. From time immemorial wells at Beersheba have supplied the Bedouins with water for their flocks. The original "Well of the Oath" as dug by Abraham is described in the book of Genesis.

Prohibition Benefits Natural History!—A new weapon has been placed in the hands of the "drys." Before the adoption of national prohibition one of the only two skulls of the mammoth, *Elephas primigenius*, adorned a Cincinnati barroom, the proprietor of which refused all offers for it. Now that his business has been legislated out of existence, the skull has been acquired at a modest price by the U. S. National Museum.

The "Rain of Blood," a curious phenomenon of south France and Italy, occurred recently at Monte Carlo and Mentone. After the downpour ceased the roofs, roads, gardens and shrubs of the Riviera were covered with sticky crimson. The superstitious inhabitants of the gambling metropolis were much terrified. There is, however, a scientific explanation which is perfectly satisfactory. It is that the rain clouds had been saturated with red sand from the Sahara Desert.

Mating Habits of Wrens. — Prentiss Baldwin of Cleveland told the Wilson Ornithological Club the results of his investigations of the migrations of birds at his Cleveland home and also at his winter place in Georgia. Contrary to general belief, the house wren frequently is divorced from his mate during the season, said Mr. Baldwin. Some wrens return year after year with the same mates, while others have been discovered with two different mates in the same season.

X-Rays in Material Testing.—X-Rays are now being used to show up defective materials, workmanship and weak metal castings in airplanes. Grains of wood in airplane parts are brought out remarkably and it is easily discernible where two different woods have been joined together, a point of construction prohibited in airplane work. Knots in the wood are also shown up, and also unsatisfactory gluing together of parts. Electric heater coils are inspected by X-ray and the plates show the manufacturer where air has caused the insulation of the coil to disintegrate, and where the wire will eventually break.

Permanent Sprinkling.—It is possible many of our readers have wondered at the appearance of the tracks at the subway stations in New York City. There is usually a realistic Christmas snow on the tracks, but the Interborough Co. has a method in this artificial snow system. The road-bed around each station is spread with calcium chloride which has a peculiar property of drawing moisture out of the air and turning gradually from a white powder into drops of liquid which remain in this condition for months. This serves to hold the dust and bacteria like the sprinkling of a dusty street. The hurtling of trains through the stations have little or no effect on this deposit.

Alaskan Volcanic Fires.—At the recent meeting of the American Society for the Advancement of Science, Dr. Robert F. Griggs described a fiery flood which occurred in Alaska, in the "Valley of Ten Thousand Smokes." Here he found traces of the flood of fire which, issuing from a fissure in the earth, swept a roaring torrent of molten sand through the fertile valley, devastating all in its path for a distance of more than fifteen miles. From thousands of fissures live steam, heated gas and smoke issued. One could do one's cooking in any of the smaller holes. And that was the only salvation of the expedition, for all fuel had been destroyed by the flood of fire. It is only a few steps from the steaming fissures to a cave in the side of a glacier in order to have the most perfect refrigeration in the world. The explorers' tents were steam-heated, as it were, and the bathing conditions were of the best for a stream from the glacier fed a crystal pure lake and in the middle of the lake a steam jet bubbled and it was possible to get any desired temperature.

Aeronautics

New Deutsch Challenge Cup. — It is understood that Madame Henry Deutsch de la Meurthe has intimated to M. Michelin, president of the Aero Club of France, that the Deutsch family will present another international challenge cup for the greatest speed achieved in an airplane, together with a prize of 200,000 francs.

France-Morocco Air Mail Service. — According to information which comes to us from *Aeronautics*, the air mail service between Toulouse, France, and Casablanca, Morocco, which has been in operation for some time past for the outward transmission of letters to Morocco, is now being carried on three times instead of twice a week in each direction.

Airplanes and Forest Fires. — According to *Aerial News Weekly*, airplanes of the Army Air Service operating in California and Oregon doing patrol duty located 494 forest fires in less than two and one-half months. Fifty-three of these fires were reported by wireless from airplanes assigned by the Air Service to coöperate with the Forestry Service in protecting national forests from fire.

Bombing a Battleship.—Although they succeeded in making a rather sorry mess of the obsolete battleship "Indiana," which the Navy has turned over for aerial experimental purposes, the five seaplanes of the "F.S.L" type did not succeed in sinking her. While the battleship was under way at a speed of 10 knots—she was controlled over an erratic course by wireless from the "Ohio" five miles away—the seaplanes attacked her and five of the 25 bombs hit the target squarely. Part of the deck was torn up, the smoke stacks suffered severely, and the deck was strewn with débris, but the old battleship still remained afloat.

German Views on Amphibians.—German aviation experts are expressing their views freely in regard to amphibian aircraft, writes the Handley-Page Berlin correspondent, and are skeptical as to the practicability of using the Thames in the center of London as the starting and landing place of these huge flying machines. They point out the dangers and difficulties which in their opinion must inevitably arise on rivers flowing through the center of such cities as London and Paris, where the shipping traffic is already sufficiently congested. Another objection raised by German aeronautical engineers is that the useful load and the earning power of the amphibian are less than that of the airplane.

That Caproni Giant. — For a long time back rumors have been coming to us of the remarkable giant machine being constructed by the Caproni Brothers of Italy. Now we learn that this machine, a huge flying boat with a capacity of 100 passengers, is completed. It has cost $800,000 to construct, and over four years of constant labor. The machine is remarkable for the absence of a tail. It is composed of three sets of three planes each, above a long fish shaped boat. The passengers are carried in the cabin which forms the boat body. The length of this machine is 75 feet, and the width 108 feet. It is equipped with eight 12-cylinder motors. The total lifting capacity is twenty-six tons.

Aviation in France. — Speaking at the Aero Club of France recently, M. Flandin, Under Secretary for Aeronautics, said that whereas in 1919 the aggregate distance flown in France was 218,750 miles, the distance flown in the first ten months of this year totaled 937,500 miles. Likewise the number of passengers carried grew from 960 in 1919 to 6,750 in the ten months of this year, while the amount of mails carried increased from 9 hundredweight in 1919 to well over 5 tons this year. The cost to the State in subsidies amounted to about $600,000. He went on to say that there were now 2,800 miles of routes in France in regular operation. The ratio of accidents was one to every 62,500 miles flown, and the fatal accidents worked out to one for every 134,374 miles.

Aircraft and Thunderstorms.—An experienced flier discusses the possibility of airplanes in flight being struck by lightning during a storm, in a recent issue of *Illustrierte Flug-Welt*. His remarks are based on some seventy flights under such circumstances and on general principles. He shows that no danger is to be expected in the first place if the machine is not in the direct line of the discharge, and in the second place even if it is, it is not likely from the nature and distribution of the conducting metal portion that danger due to fire will arise. Out of thirty cases where the machine was struck directly, the writer maintains that there were no evil effects, while in all known cases in Germany where a machine fell during a storm there was no evidence of scorching of parts or melting of metal.

A Giant Job of Underpinning

Building a Subway Beneath Philadelphia's City Hall, with Its Inadequate Foundations

By William A. McGarry

PHILADELPHIA subway engineers have just completed what is conceded to be the largest underpinning operation in the history of the world. Since the cost of building a 700-foot station in connection with this work has been almost $3,000,000—or between $21,000,000 and $22,000,000 a mile—it is probably also the most expensive piece of subway construction existing.

Briefly, the tremendous weight of one hundred thousand tons, one quarter the total mass of the Philadelphia City Hall, was shifted twice with an average settlement of but one quarter of an inch. This great pile was transferred first from its original defective rubble foundations to new foundations of concrete and brick. Subsequently the rebuilt foundations were incorporated in and supported by the subway roof, which, in turn, was supported by concrete walls carried to rock by steel piles.

The contract for this work was let in August, 1915. It called for the construction of the central subway station in the city's proposed new system of underground railways, a four-track affair with as many platforms, and with mezzanine and gallery floors to distribute traffic, all to cut under sections of the north, west and south walls of the City Hall and under the north and south branches of the Market Street Subway which circle the hall at present.

Only the usual preliminary surveys had been made prior to the signing of the contract, and these in no instance revealed the character of the foundations of City Hall. That building was constructed many years ago, before steel skeleton work came into general use. It is a seven-and eight-story structure of solid brick and masonry, covering an area of four acres around a square courtyard, and it stands in the center of the intersection of Broad and Market Streets, the two main central traffic arteries.

Because of the method of construction it was known from the beginning that the task of running a subway under this building would be a delicate operation, as masonry structures are extraordinarily heavy and liable to crack or even to collapse when disturbed. But the engineers, although they consulted what building records were available, failed to take into consideration the element of politics in the original work. They assumed that, since the building had stood for nearly half a century without showing any but minor cracks, its foundations must also be of solid masonry, the underpinning of which would be a difficult task for the reasons stated, but not at all outside the range of engineering experience. Plans were made and the contract let on this assumption, and work was started late in 1915 at the northwest corner of City Hall.

Within a few days the excavation had been carried down to the foundations of the building. And then the engineers discovered that these consisted in great part of rubble made of loose rock and gravel, with hardly any mortar. It was found that the builders of the structure excavated trenches in some instances almost in the form of inverted pyramids. These were filled with the rubble. Then a masonry course was started, but it was so poorly constructed that in some places there was room between the slabs of stone for a man to insert his head and shoulders. Above this came a solid wall of brick work to the basement of City Hall.

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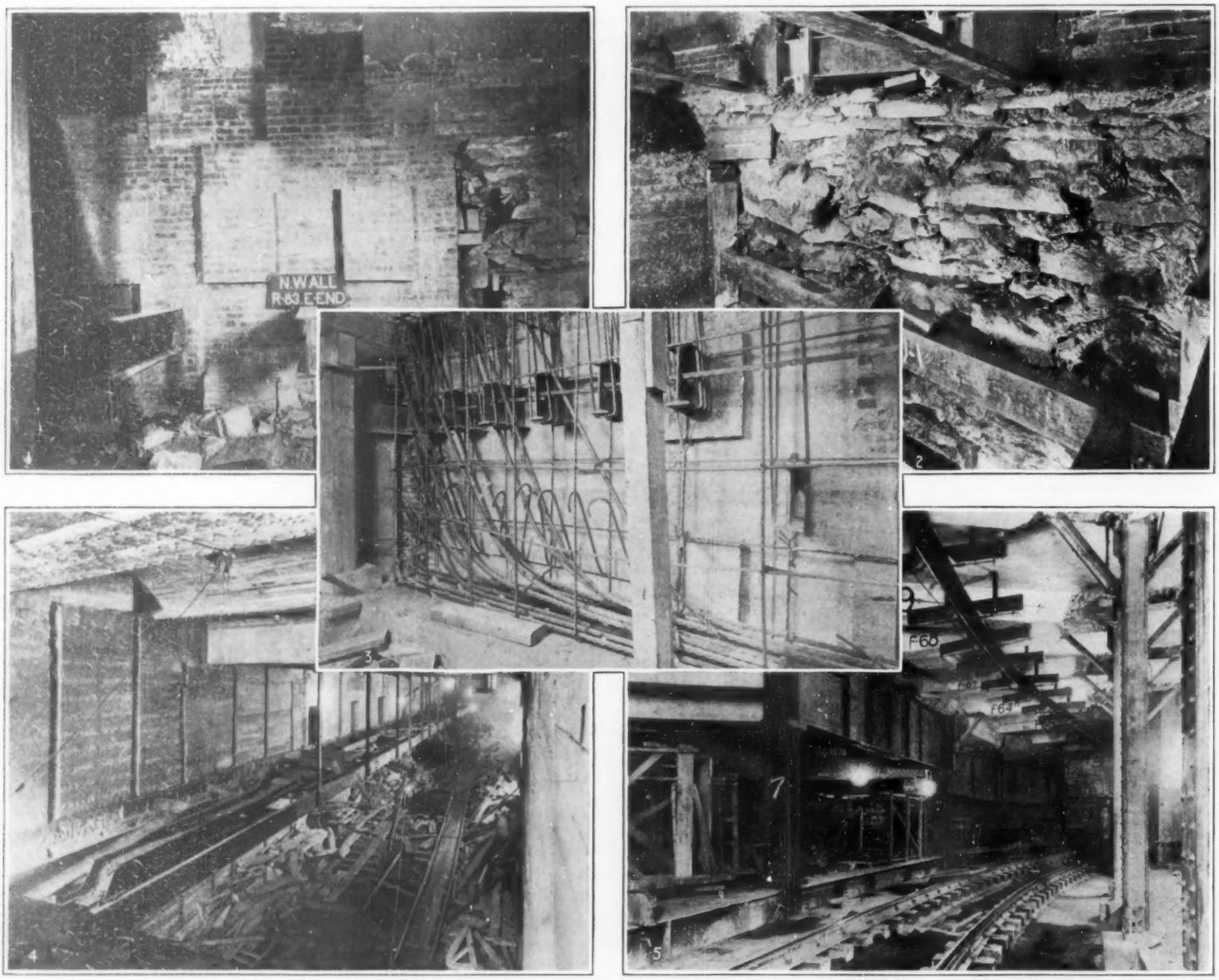

1. The old rubble foundation and a section of the new brick underpinning. 2. Another view showing the scandalous character of the old foundation. 3. The new foundation of concrete and brick, the steel needle-beams for transmitting the load of the building to the subway roof-girders, and the reinforcing rods for the concrete of the roof. 4. One of the track bays, showing the steel work of the hanging gallery connecting the mezzanine floors; also the five- and eight-foot piers, built at different times but in perfect alinement. 5. Steel work for supporting the existing subway in Filbert St., in connection with the under-crossing of the new tube.

Building a subway under Philadelphia's insufficiently supported City Hall

Why Balloons Bounce Off Clouds

By Lieut. Corley P. McDarment

MUCH of the interesting and unusual phenomena observed by man since he has begun to traverse the "upper regions" has never come to the attention of the general public. This is largely because those who navigate the air soon become accustomed to strange incidents and after a short time begin to consider them commonplace and as facts of common knowledge.

For this very reason numerous interesting aerial experiences are discussed among those of the profession alone. It will probably be many years before a large number of the so-called "secrets" of the air are revealed to the layman who runs only on terra firma.

Airplanes sink readily and easily into the great masses of soft clouds, but balloons bounce off them like a rubber ball against the floor

One of these phenomena, and a remarkable one too, about which little has been said outside aeronautical circles, is the peculiar bouncing of balloons when they strike a cloud. It is rather an uncanny sight to see a balloon sailing gracefully along and encounter a large, fleecy cloud, when, as the gas bag touches and starts sinking into it, away goes the sphere like a rubber ball that has been batted. Needless to say, a person has a weird sensation the first time he is up in a balloon and gets "bounced" in this way.

A glance into the law governing this curious action discloses the fact that it could not happen otherwise unless several fundamental rules of science were changed. The gases used in balloons, as everyone knows, are lighter than air and normally rise. Omitting the discussion of why they rise, it can be said that the rising is on the same principle which causes cork to float to the top of water when it is released beneath the surface. A piece of cork as it rises has a certain amount of upward pull which is directly proportional to the size of the piece. A big piece will exert more upward pull than a smaller one, the quality of both pieces being the same. This is true of all substances which are lighter than water. If weights be attached to the pieces of cork, the large piece will buoy up the heavier weight; the difference being due to the size of the piece. The reason why a large piece of cork will lift more weight under water than a smaller one is because of the difference in water displacement. Likewise with balloons, a big balloon will lift more than a smaller one because of the air displacement. And this brings us right up to the "bounce" of balloons off clouds.

It is well known that the air in clouds is cool and damp, and it has been found by aerial navigators that just above the clouds there is a stratum of warm air. This layer of warm air is caused by the radiation of the sun's rays from the clouds, and is similar to the layer of warm air that lies near the ground on a summer's day. Now, when a balloon is released from the earth and there are clouds above, it goes rapidly upward until it strikes the cool air just inside the surface of the cloud, whereupon the gas in the bag is cooled suddenly, and in accordance with the law of gases, it contracts, or shrinks, and occupies a much smaller space. In other words, the big balloon that started up has become a smaller one with less air displacement. The moment this air displacement diminishes, the balloon drops precipitously just as a rubber ball that has been thrown against the wall or ceiling. But, unlike the ball, it descends only until it encounters the warmer air near the earth where the gas is again heated and the balloon expanded. When this occurs, the balloon rises once more, and the process is repeated as before unless sufficient ballast is thrown out to neutralize the shrinkage of the gas bag. If this is done the balloon will rise on up through the clouds. However, the moment it emerges on the upper side of the cloud the warm air layer existing there heats the gas and expands the balloon, and all the ballast that was thrown out below is now needed to check the too rapid ascent. This difficulty is overcome by letting out some of the gas.

Having risen above the clouds, it is just as hard to get the balloon down again as it was to get it up. A reverse condition, with more danger involved, has to be overcome in "nursing" a balloon down through a layer of clouds. When a balloonist high above the clouds desires to descend, he lets out gas, thus diminishing the balloon's air displacement. He comes down beautifully until his balloon encounters the warm air just above the clouds where the gas is suddenly heated up and the bag expanded, then, lo, he has a big balloon on his hands when a moment before he had a smaller one. This big balloon with its added lifting power shoots rapidly upward, giving all the appearance that it had "bounced" off the cloud. It goes on up until it strikes cooler air again when the gas bag shrinks, and the aeronaut has a smaller balloon once more. This little balloon will again descend and bounce off the clouds as it did before and will continue the performance until tactics are employed that are opposite those used in getting it up there. Of course this would not keep on indefinitely as some of the gas is constantly being lost and the balloon would finally come down for this reason alone as soon as enough gas leaked out. But, whenever an aeronaut wishes to "pilot" his balloon down through clouds, he releases a considerable amount of gas just as he enters the warm layer of air. Immediately after this warm air is passed through and the balloon is within the clouds, ballast must be thrown out with great alacrity because the cool air of the clouds will contract the gas bag so much that when it gets below it may be falling so fast that it will go on to the ground. This is a dangerous thing, especially when the clouds are near the earth. In a fog balloons often drop with a speed not calculated to be conducive to the good health and physical unity of mortal man. But it is an effect that is con-

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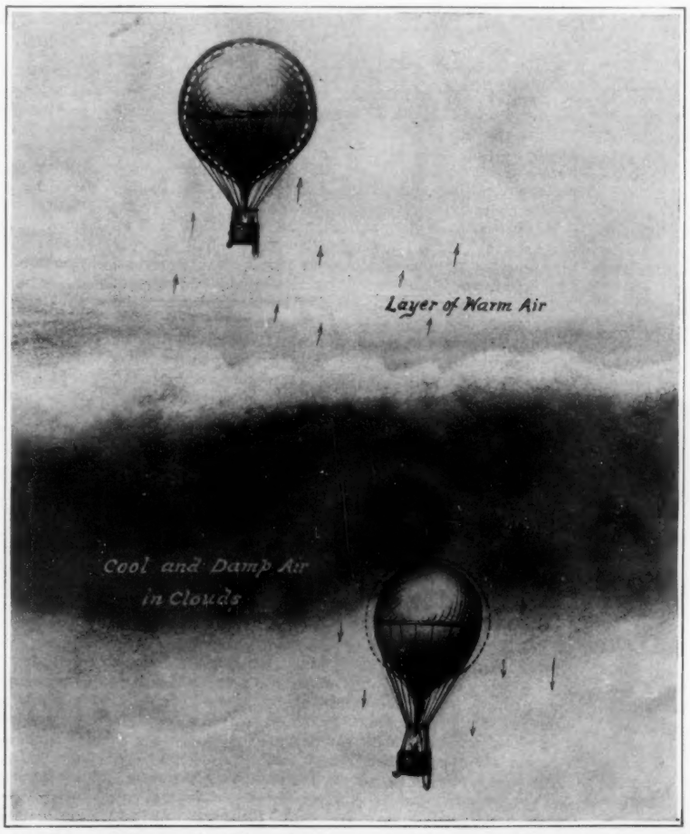

A balloon will bounce in either direction, up or down, when it meets a layer of warmer or cooler air that expands or contracts the gas in the bag

The Vacuum Tube as an Engineering Problem

By W. C. White

THE thermionic amplifier, three-element tube, vacuum tube, hot-cathode tube, valve, triode, audion, pliotron, etc., as it is variously called, is fairly widely used and its fundamentals known to a great many people. In radio communication its use as a detector and amplifier is of great importance, and its use as an oscillator in radio transmission is rapidly increasing. Acting in this latter function, it has many applications in other branches of electrical engineering and science.

The fundamentals of the design, construction and operation of the power tube or oscillator have been quite thoroughly worked out by the scientist and physicist. In fact, at the present time laboratory accomplishments are far in advance of the product as regularly manufactured and used. This condition is typical of almost every new device.

One definition of engineering is "the art of constructing and using machinery." Applied to the point in question, engineering is required before the power oscillator tube can progress from the laboratory to the condition of giving widespread satisfaction in its everyday use. Of these two steps, the "construction" is much the simpler and quicker because it can be concentrated in specialized groups trained and organized for the work.

The second step, "art of using," is a very different matter. It is in the hands of the many users, and they are not usually particularly interested in the device itself, but rather in the function it performs or the service it renders. Education is therefore necessary so that the user understands the many features of the device and an acquisition of this knowledge by large numbers of people takes time.

This condition is not peculiar to the vacuum tube, but is a common condition in the evolution of many engineering devices.

As an example of this and as a device to use in comparison with the power vacuum tube, consider the rotary converter. This device can produce alternating current electrical energy from direct current energy and thus fundamentally performs the same function as the power vacuum tube.

In the way of design and construction, electrical engineering has slowly built up a method of specifying, describing and rating the characteristics of a rotary converter. The user and manufacturer have commonly understood terms such as input A. C. voltage, output D. C. voltage, input A. C. current, full load D. C. current, speed, frequency of generated energy, regulation, excitation volts and amperes, kilowatts rating, allowable temperature rise of certain parts and many others. A vacuum tube used as a generator of alternating current has many characteristics in common with the above and others peculiar to itself.

However, these factors are as yet not usually understood by those planning to use tubes, nor are all of them as yet fully investigated or understood by the manufacturer.

A rotary converter built without regard to these many characteristics would hardly be expected to function with entire satisfaction, yet that is usually the way vacuum tubes are used.

Fortunately a vacuum tube is an exceptionally flexible piece of electrical apparatus and does remarkably well under different conditions.

Now carry the comparison into the field of operation.

The person operating the rotary converter even if not highly trained, knows a great many points in connection with its care. He knows the bearings must be oiled, that the windings must not be allowed to get wet, that grit and dirt are not good for the commutator, that a smell of overheated insulation is a sign of trouble, and many others. He knows that if with a normal output the input is abnormally high, something is wrong and he will take steps to locate and remedy the fault.

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Pumping Coal from Mine to Seaboard

A Scheme for Shipping This Fuel via Pipe Lines, Much as Oil Now Is Shipped

By C. H. Thomas

A PROJECT to bring coal from the anthracite regions in Pennsylvania into the city of New York through two 14-inch pipes by water pressure has been put forward by Reginald P. Bolton, A.S.M.E. Between New York and Scranton, Pa., there is a difference in elevation of about 2,000 feet and Mr. Bolton believes that this would make it as easy to transport coal as water. He claims 7,000,000 tons of coal could be brought through the pipe every year, amply supplying the city's needs. The general scheme is one that has been known for a number of years, and it has been tested sufficiently to demonstrate its undoubted success.

One of the important effects of the establishment of a system of coal storage is the continuity of operation in the mining of the fuel. It is authoritatively stated that about sixty per cent of the total annual coal production of certain fields is mined and marketed between the months of October and February, while only forty per cent is mined in the remaining seven months of the year. This situation is mainly due to the difficulty of disposal of the fuel during the latter period, which could be advantageously utilized for the purpose of creating and replenishing fuel reserve stocks. The loss to a single mine by an idle day is stated to average about $300, and in the case of large mines, would be as high as $1,000. The situation therefore in regard to the cost of coal could be beneficially affected by the establishment of reserve or storage in large quantities.

The mining situation would also be substantially improved by the establishment of the pipe line system of transportation, because much of the present sporadic and irregular operation of the mines is due to the difficulties of car movement. It is stated by an authority that it is rare for any mine to be able to work more than six out of eight hours, on account of the difficulties of car service.

The system of transporting coal with water in piping has been so far tested as to demonstrate its practicability. On a small scale the system has been in operation in a plant in the city of London since the year 1915. This plant, which has a capacity of fifty tons of coal per hour, conveys the fuel a length of 1,750 feet through an eight-inch pipe having several bends, and raising the coal at the discharge about seven feet. The cost of this operation is given as six cents per ton. Some tests were also made in Chicago of this system which were considered to have established its practicability from a mechanical point of view. It may be assumed therefore that with proper consideration of the circumstances such a system could be practically applied to the transportation of fuel over a long distance, and that the circumstances would be favorably affected by the difference in level between a mining region and the seaboard, as in the case of the city of New York. It may be noted in this connection, that oil is now pumped over a distance as great as one hundred and seventy miles in California, through eight- and ten-inch pipes, and over a distance of thirty-six miles in an eight-inch pipe line at a total cost per barrel of less than .04 cent.

A study of the probable conditions and expense of construction of a coal transportation line from the Scranton region to New York indicates a probable investment of approximately twenty millions of dollars, and with all operating costs and fixed charges on a liberal scale, the cost of coal transportation would appear to be less than seventy-five cents a ton. It will be evident that there is a very substantial reduction in the expense of the transportation of the fuel to be anticipated by the use of water transportation, and that in addition the cumulative effects of this method of coal delivery, and of the establishment of a large storage would be to reduce the cost of operation at the mines, thereby effecting a reduction in the cost of production. It may be fairly assumed that under existing conditions the establishment of this storage and transmission would reduce the price of fuel about $1.50 a ton.

The recent car shortages have been responsible for the high prices of coal in all parts of the country. The output was not available when needed and the consumer had no assurance when it would be delivered. With the water system of delivering coal, a constant supply would always be available and the price correspondingly lower at all times, with the mines operating at full capacity.

As to the matter of preparing coal for shipment in this way it would have to be first pulverized, and mixed with water for transportation by pipe line. It is a well-known fact that coal from certain mines must be prepared for use and that the specifications for certain purchasers require this preparation. The preparation plant bears close resemblance to a standard ore-concentrating plant, being erected along the slope of rising ground to secure the benefit of gravity in the preparation of the coal. The shed-like building is about 200 feet wide and extends up the slope about 300 feet. At the upper end is the railroad leading to the mines, the coal generally being received into hoppers directly from the mine cars. At the lower end of the building is the steam plant, while along the valley a stream of water is to be found. Some distance upstream is a dam and reservoir, while some distance downstream in a large valley is the dump pile containing the impurities removed from the coal. A snake-like mound following along the bank of the stream covers the pipe line which carries the prepared coal to market. Adjacent to the plant are two large coal storage reservoirs. Upon entering the plant at the point where the coal is received, we find large receiving bunkers under the tracks. These bunkers discharge the coal by gravity into large crushers, each of which is capable of reducing the coal to sizes not exceeding three quarter lump. These crushers and all other machines throughout the plant are electric-driven. The coal is then sent to the jigger, which is a washing

(*Continued on page 139*)

Little Things That Count Big

The Refinement of Details That Marks Our Present Railroad Development, and Some of the Further Needs

By Herbert T. Walker

IN these days, when our existence depends so much on mechanical appliances and especially on the machinery of transportation, it is a matter of great importance to improve, and, so far as possible, to perfect, even the smaller details of construction that go to make up our vast system of railroads.

When our timber supply was ample, the cost of wooden railroad ties was so low that no one thought of making them of any other material. The time is coming, however, when wood will not be available for this essential part of the track and a substitute will have to be found. Steel ties have been tried, but they were noisy and there were other objections to them. The indications are that concrete is the coming material and a simple yet safe means of fastening the rails to concrete ties should engage the attention of inventors. In the meantime, so long as wooden ties are in use, there should be an improved way of securing the rails to them. The time-honored driven spike, pounded in by the track man's sledge hammer, crushes and tears the wood fibers. In a short time, water gets in, rots the wood and the spike then becomes free, losing its hold on the rail. The natural consequence is that a heavy fast train will spread the track and a derailment, more or less serious, will result. It is true that screw spikes are now in use, but even these are not free from the defects of the driven spike, and at least one of our trunk lines is reverting to the old-time method.

We will now look at the locomotive. It is the most self-contained form of the steam engine. More time and study have been spent over its development than on any other form of motor. The last few years have seen great improvements, making for efficiency and economy; chief among them being the water tube and fire-brick arch, feed water heating and superheated steam. It is still, however, a wasteful machine. Smoke box temperatures are far too high and much heat is blown out at the stack by reason of the powerful blast of exhaust steam required to urge the fire for rapid steam generation. This sharp exhaust can only be produced by contracting the area of the exhaust steam pipe by what is known as a "blast nozzle." This device may be classed as a necessary evil, inasmuch as the more we restrict the area of the blast nozzle the greater will be the back pressure on the pistons, limiting the power and speed of the engine to a serious extent.

Many forms of blast nozzle have been tried, and as far back as 1838, Brunel and Gooch applied a short pipe, having an opening shaped like a Maltese cross, to an engine on the Great Western Railway of England. This nozzle increased the area of steam exposed to the gases from the fire, thereby strengthening the draft without choking the exhaust steam from the cylinders. Like some other inventions, it was in advance of its time and was abandoned. There is a good field for the inventor in the way of producing a *variable* exhaust pipe which will pull the draft through the fire without excessive back pressure, and it would seem practical to design some way of reducing the area of the blast nozzle when starting the engine, for at that time the volume of exhaust steam is comparatively small and back pressure negligible. As the engine gained speed, the blast orifice could be expanded and back pressure greatly reduced. This could be done either by the fireman or made automatic by a simple connection with the reversing lever of the engine.

When the electric locomotive is drifting or running with the power shut off, the current generated by the motors is transmitted to the feed wires and helps to haul other trains. This operation also retards the train and saves a lot of energy otherwise spent by the air brakes. This is known as "regenerative braking" and is a feature much emphasized by advocates of electric traction. The system cannot be applied to the steam locomotives, but some arrangement by which the energy now wasted in stopping the train could be saved and the train's momentum stored up to assist the engine when starting would be a great advantage, especially in the case of trains making frequent stops. It is suggested that, by some suitable arrangement of suction and discharge valves and a connection with the reversing gear under control of the engineman, the cylinders could be converted into air pumps, forcing air into a receiver either on the engine or tender. When starting the train, this air could be used in a supplemental motor geared to the trailing wheels of the engine. This would greatly assist the locomotive and would shorten time between stations. If found objectionable to draw cold air into the cylinders, especially in the case of superheated locomotives, the supplemental motor could be used as an air pump, converting it into an air driven engine when starting the train. This auxiliary power would not use any steam and should be worthy of a trial.

If a car journal or journal-box breaks the car will be derailed with more or less serious results. It is suggested that an emergency journal box be fitted to the axle and truck just inside the wheel. This box would only come into use if the main journal failed.

There is room for improvement in the way of ventilating our passenger cars. It is the same today as it was fifty years ago. The transoms in the clere-story roof cause down drafts and have to be closed in cold weather. The only way to get fresh air, if the transoms are closed, is by opening the windows and letting in a shower of dust and cinders. This may not inconvenience the person occupying a seat at the window, but to one sitting in the next seat behind it is often a nuisance, as people's ideas of temperature and drafts differ widely. Pullman cars are provided with outside window shields which break direct drafts, but day coaches have no such convenience. It would appear practical to devise a small fan-shaped screen of strong flexible material that would fold back into a recess in the window casing when not in use. If one of these screens were installed directly over the back of each seat, a passenger not desiring to sit in a draft could pull out the screen and fasten it to the back of the seat in front of him, thus protecting himself and giving the person ahead the full benefit of the wind.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

The Thousand-Dollar House and Its Near Relatives

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of December 11, 1920, you have an article by Mr. Mount, "A Review of the Building Situation," etc. In separate box you ask, "Can a house be built for one thousand dollars, and how?"

I am enclosing a plan for a permanent house that can be built for one thousand dollars. The walls, 18 x 30, are to be built with hollow concrete wall construction. The floor space is 540 square feet. The walls are nine feet high, the ceiling eight and one-half feet high. Cement foundation, floor and steps are provided. Ceiling is wood lath and plaster. Roof is covered with composition roofing. The house will accommodate six persons—four very comfortably, but six can get along fine. Two very good sized rooms with space between for closets, toilet, sink, shelving, cupboards, two closets for closet-beds (rolled in on end), pantry and plenty of room for necessary articles.

The wall is built a story at a time in one operation, there being a complete air-space from foundation to plate for the entire circumference of the walls. This provides a wall that is cool in summer and warm in winter. A wall which will exclude moisture and vermin. Plaster direct on the inside wall.

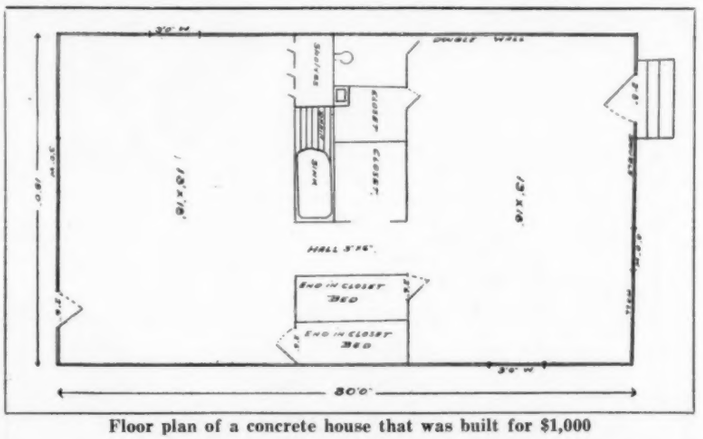
The cost of this house is based on cost of material and labor here. To wit: carpenters, $8.00 per day; plasterers, $12.00; common-labor, $5.00; lumber, $47.00 to $80.00 per thousand; rock, $3.00 per yard; sand, $2.00 per yard; cement, $4.00 per barrel; wire lath, 5½c per square yard; reinforcing rods, 8c per pound, and painters, $8.00 per day.

One of the houses we have built this year was rented in March at $25.00 per month for one year. I give you cost, as I kept books, and will just itemize it for your benefit: Carpenters, $253.44; lumber and doors and windows, $890.85; drayage, $31.00; chimney work and all, $7.80; material, labor, cement, etc., $608.22; plastering inside and outside, $270.00; painting, $147.00; wiring, $38.00; fixtures, $26.50; plumbing, $385.00; linoleum and shades, $36.00; steps, caps, porch and porch wall, $109.60; locks, hinges and screens, $49.75; cesspool and ditches, $30.00; roofing, $64.00; sand, rock, etc., $87.29; piping gas from alley, $26.05; clothes hooks and hedge bushes and cleaning floors, $8.40. Total, $3,068.90. The plumbing consists of toilet, double wash trays, bath tub, sink, hot-water boiler, lavatory, drain-tile for sink, and yard piped for watering lawn.

J. R. RICHARDSON.

Madera, Cal.

This house, of similar construction to the thousand-dollar one diagrammed below, but considerably more elaborate in construction, cost, including the bushes for the hedge and all the other trimmings, barely $3,000



Floor plan of a concrete house that was built for $1,000

Built: An Inexpensive House

To the Editor of the SCIENTIFIC AMERICAN:

In the December 11, 1920 issue of the SCIENTIFIC AMERICAN there appeared an article under the head of "Wanted: An Inexpensive House." The author gave a number of very timely suggestions on the building subject, but as the Editor remarked, our housing problem yet remains unsolved. It is to this end that this article is being written.

The Editor also asked if any of his readers could solve the $1,000 house problem. The subject was stated in such a way that it was impossible to tell whether he wanted to know if a house could be built for $1,000, or if a man having $1,000 could build a house, and borrow enough to see his undertaking completed.

Within the last four years I have built two houses, the smaller one being a house for less than $1,000; the other, an eight-roomed house, may be classed as an inexpensive house, being built between May 30, and September 15, 1920, and costing less than $3,000.

I am only 26 years old, and do not consider myself to have any more than ordinary ability in any particular line whatever, and what I have done, I feel sure others may do also, if they have the necessary ambition to go ahead and stay with the undertaking and see it through.

In 1916, just after getting married, I found myself in the same position as so many people are today. I had very little money, but decided that I must have a home of my own. I got a catalogue from a houses-to-order firm and decided to build one of their models, with certain changes I made in it after it arrived. The 6 x 17-foot porch was not included with the ready-cut house, neither were the stairs at the end of the living room. After putting in the stairway, I floored the attic, which proved to be an excellent place for trunks and the like. This house cost me at that time (September, 1916) completely finished, $400.

In 1920 I put on an addition, fitted the house with electricity and built the chimney, for $260 more. This house is very comfortable and of exceptionally good material and still cost less than the $1,000. Even now, making the allowance for the increase in wages, freight rates and cost of material, I think this house can be erected for less than $1,000. Any man, with the aid of one experienced carpenter, should be able to build a house of this kind in two weeks.

But you may say that what was done then cannot be done now. You know as well as I, that when a man contracts to build a house for you, he must figure his profit high enough to cover all expense, whether known or unknown at the time of the contract, and still allow himself a handsome reward for his labor. But if you have the ambition to tackle the job yourself and see it through, you can build a house for about one-half what a contractor would ask. This house was built at a time when labor was at its highest, prices on material were high and material was hard to get at any price.

About the first of May, 1920, I found that it was going to be necessary for me to build another house. At the time I had a lot to my title and about $1,200 in sight. I wrote for catalogues of ready-cut houses, but not being able to find anything quite to my liking, also began to draw plans of my own and compare prices with lumber companies. I went to a carpenter and asked as to the amount of time that one might save in buying a ready-cut house, and he advised me that a man could cut his own lumber quicker than he could hunt for the material in a ready-cut house. I decided then to build from raw material, if I could come anywhere near the price of the ready-cut dealers.

I went to a local lumber company and asked about what it would cost me to build a house, over the plans I had drawn. They informed me that they did not take contracts, but that they would get in touch with a local contractor and give me his estimate in a few days. Just as I was about to turn away, the proprietor of the company asked me: "Why don't you boss the job yourself? I'll give you prices on the different materials, and send all you want to the job and what you don't need I'll take back." I told him I would think it over and he was to let me know what the contractor's estimate was in the meantime.

I again returned to the carpenter for advice and told him just what the lumber man had said. He made out a list of the material it would require to build a four and an eight-roomed house on the same size foundation and then told me to see what kind of an estimate I could get on that amount of material. He also agreed to build the house, hire a helper and see that it was put up right for a certain sum per day. I returned to the lumber man with the list of materials and to my surprise found that it would cost only about $500 more to build an eight-roomed house than it would a four, so I decided that it should be an eight. The contractor wanted $6,000 for the job, so I told him that I would boss the job myself.

I began digging my cellar, which was to be 24 x 24, on May 30, and by the last of June I had it ready for the bricklayer. I did my digging before and after working hours. Then my next job was to find a bricklayer. Fortunately I found one who would have an off day on the following week, and he said that if I would have the necessary materials on hand, that he would bring a helper and tender and finish the job on that day. It required 554 tile at 32 cents each, 13 sacks of cement at $1 each, and about 40 bushels of sand at 25 cents. The labor on that job amounted to $36, so the cost of the foundation, less my own labor, amounted to less than $250.

Then the carpenters came on to the job. Every day I would 'phone the lumber company of my needs for the following day. It just required four weeks and three days of actual carpenters' labor to finish the job. One more day was required of the bricklayer and his two assistants to build me a chimney, having three flues, one of them having special liners running down to the cellar for a furnace. This chimney required 2,500 bricks, and the labor on the job cost me $28.

The roof of the house was made of composition shingles, well nailed with copper nails. I used plaster board on the walls, instead of plaster, as that represented a saving of about $200. The wiring I did myself, and this saved several dollars. The paint for the building was purchased from a local painter and I put that on after working hours.

With the painting, spouting and everything finished, I figured up my bills and found that it was only necessary for me to borrow $1,620 to clear all debts. The lumber man gladly went my security for this amount. The entire amount of money spent on this house, from the time I started to dig the foundation, until it was ready for occupancy, was $2,838.22. The material, not including the chimney, from the foundation up, amounted to a little over $1,700. And prices of things were at their highest at that time.

Just a word about the plans, before closing. We have five large closets, an especially large one over the stairs, which in most houses is only lost space. In the whole plan you find not a single square foot of lost space anywhere.

As for arrangement, I do not see how it could have been improved upon, without the expense of an extra chimney.

A. J. MCCLOY.

South Brownsville, Pa.

Motor Fuel in Great Britain

UNDER the pressure of high prices and a scarcity of motor fuel in Great Britain new laboratories have been provided to study the possibility of substitutes. This is under Prof. H. B. Dixon, who will begin his work with alcohol produced from vegetable materials.

How We Think

The Microscopic Structure of the Intellectual Portion of the Human Brain

By Leon Augustus Hausman, Ph.D.

ONE of the most interesting and significant revelations of the modern study of the structure of the human brain is that there exists an extremely intimate association between the structure of that organ and the various aspects of thought, emotion, and other mental phenomena. It is now a well established fact that all mental processes are explainable upon the basis of brain structure and activity. No mental activity can be carried on without brain-cell activity. The experiencing of sensations and of emotions, the perception and remembrance of objects, the formations of judgments, and the construction of long and intricate trains of complex reasonings, in short, all the varied operations of the mind of man are necessarily bound up in the operations of the brain. Complexity of brain structure means complexity of mental activity.

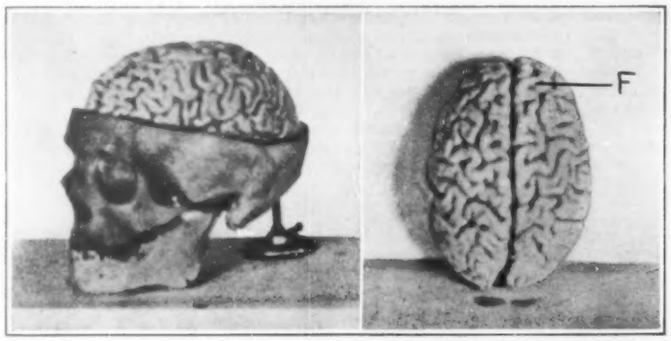


Fig. 1. The cerebral hemispheres in place, in the skull, the upper portion of which has been removed to render their contents visible.

Fig. 2. The hemispheres, seen from above. *F* indicates the frontal region, where the active thought phenomena are localized.

Two views of the cerebrum, or thinking portion, of the human brain

In view of this close association between mental phenomena and brain action, it is logical to expect that a close parallel exists between the general intelligence of any given human being and the structural development of its brain. The researches of many able scientists in the field of brain structure and development have resulted in the accumulation of an array of facts whose correlation and interpretation enable us to establish, with tolerable certainty, the main features of the laws of relationship between intelligence and the brain. We may say, at the outset, that intelligence is the result of the growth of certain minute structures in the brain.

The study of this relationship of brain matter to intelligence may be pursued in several ways. We may endeavor to correlate degrees of intelligence with degrees of weight of the brain mass as a whole, or we may endeavor to discover the relation between mental growth and the growth of the structure of the brain. The latter field of research has proved the more fertile of the two, particularly the study of those physiologically ultimate elements of the brain structure, *i.e.*, the nerve cells, or neurones. Cells are the units of living matter, built up into bodies, very much as bricks are the units of structural matter that are built up into buildings, bridges, etc. The cells of the nervous system are known as nerve cells, or neurones. They differ considerably in various portions of the nervous system, but their fundamental structural characteristics are all similar. Figs. 5 and 6 show two of these nerve cells, or neurones, from different portions of the brain.

The human brain, built up of millions upon millions of neurones, is a bulky structure, weighing normally about fifty ounces in the adult. It consists of three main masses, each with various subdivisional parts, known as the fore-brain, mid-brain, and hind-brain. In man the fore-brain is the largest of the divisions weighing about forty-four ounces. It is made up of two large convoluted masses known as the cerebral hemispheres, or collectively as the cerebrum (Figs. 1 and 2). The mid-brain forms a sort of connecting link between the fore-brain (cerebrum) and the hind-brain. This latter portion of the brain consists of a large mass directly beneath the hinder portion of the cerebrum, called the cerebellum; a smaller mass, directly in front of this, known as the pons Varolii, or simply the pons; and an elongated downward-projecting pear-shaped mass, which tapers out into the spinal cord, and is called the medulla oblongata, or the medulla. Like the spinal cord, the brain itself consists of both gray and white nervous matter. The greater portion of the gray matter is spread over a large part of the outer surface of the brain, but small masses of it are likewise to be found buried in certain parts of its white interior. By reason of the numerous folds and convolutions present in the surfaces of the cerebellum and particularly of the cerebral hemispheres, the area over which this layer of gray matter is spread is very greatly increased.

This layer of gray matter over the outer surface of the cerebrum is known as the cerebral cortex (C, Fig. 3), and it is this portion of the brain, and particularly that part about the frontal region of the cerebrum (F, Fig. 2) which is most closely associated with those operations of the mind which we call the higher, or intellectual, functions.

The cerebral cortex, to which we shall confine ourselves, contains countless millions of nerve cells, or neurones, of varying forms. However different may be their configuration, each one consists of a central portion, known as the cell body (B, Fig. 6), and branches, called fibers (D, Fig. 6). In many of these cells these fibers may be extremely long, and branch many, many times, giving rise to a very complicated, root-like structure. The numerous ramifying branches of the nerve cells connect with each other, and with the branches of a host of other nerve cells, and send out fine "tendrils" and "rootlets" into remote portions of the nervous system.

The neurones of the cortex are arranged in several rather well defined layers, each layer containing neurones of a characteristic shape (Fig. 4). The thickest of these layers are called the layers of the pyramidal cells (P and P_2, Fig. 4) or neurones, since they contain neurones whose general shape is pyramidal. The pyramidal neurones are so placed that their acute apices are all directed outward toward the surface of the cortex, with their broad bases facing the central portion of the cerebral hemispheres. A correlation of the various studies made upon the microscopic structure of the cerebral cortex indicates that it is these pyramidal neurones, which, more than any of the other cells of the cortex, are associated with the higher mental processes.

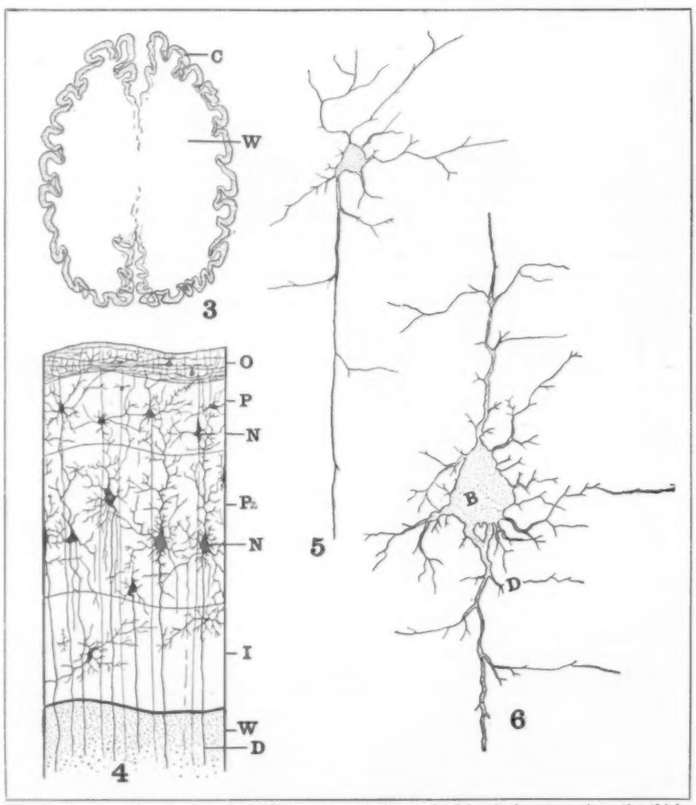


Fig. 3. Cross section through the middle portion of the cerebral hemispheres, to show the thickness of the cortex, where the thinking cells are located. *C* represents the cortex, *W* the white matter of the interior of the brain. Fig. 4. Highly magnified section through the cortex. *O* is the outer layer, *P* and P_2 layers containing, respectively, the small and large pyramidal cells, the "thinking cells." *N* is a single pyramidal cell or neurone. *I* is the inner layer of the cortex containing very few cells. *W* is the white matter of the interior of the brain. *D* are the dendrites, or fibers from the neurones, that lead into the interior of the brain for the purpose of forming connections. Fig. 5. A single nerve cell or neurone from the outer layer of the cortex, with some of its principal fibers. Fig. 6. One of the most important of brain structures, a large neurone from the second pyramidal layer of the cortex, showing the mode of branching of some of its dendrites. *B* is the cell body, *D* the dendrites or fibers.

The minute structure of the cerebrum, or thinking portion of the human brain

From the standpoint of comparative development of brain activity among animals it is significant to note that here also a definite relationship has been observed between the degree of intelligence possessed by an animal and the number and development of the pyramidal neurones. Not only in animals of superior intelligence do the neurones become more numerous, but also larger, and, moreover tend to develop longer fibers, which branch more abundantly. This results in an increased number of contacts made between neurones. In fine, we may say that the intelligence of a species is dependent upon its brain development, particularly upon the development of the pyramidal neurones of the frontal portions of the cerebral hemispheres. And the particular sort of change which we would characterize as *development*, in this sense, is chiefly an increase in the size of the cell bodies, and in the length and number of branches and interramifications of the nerve fibers.

In the human species, as well, the development of intelligence and of the pyramidal neurones of the cortex show the same parallelistic course. Researches in human embryology (the study of the child from conception until birth) has brought out the interesting and significant fact that the number of pyramidal cells in the cortex goes on increasing until the third or fourth month of foetal life. Beyond this period the number does not change. This means that the number of cortical cells of this type with which any given individual is endowed is fixed well before birth.

After the third or fourth month of foetal life, and during all the subsequent existence of the individual, the principal changes which take place among the pyramidal neurones are increase in size, texture, and in the length and ramifications of the nerve fibers. As the individual grows through childhood to maturity such are the changes which take place. It has also been noted that with develop-

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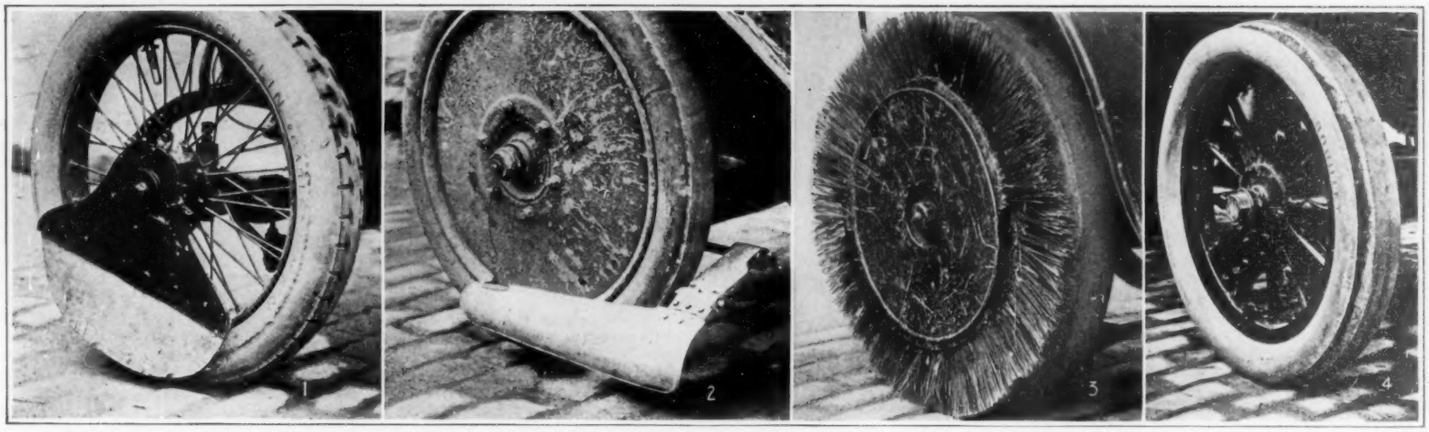


Four ingenious devices that are being tried out in Paris with the intent of preventing the indiscriminate splashing of mud from the automobile wheel

Novel Aids to the Mud Guard

THIS is the season, or if it is not it soon will be, when the automobilist and the pedestrian so unfortunate as to be forced near a moving car are united in their realization that one of the evils of automobiling is mud. The pedestrian comes home with mud flung upon him from puddle and bog-hole, while the car driver reaches his garage with a heavy coating of real estate over his wheels and the underbody of his car. Both parties would doubtless be grateful for anything that would abate this nuisance.

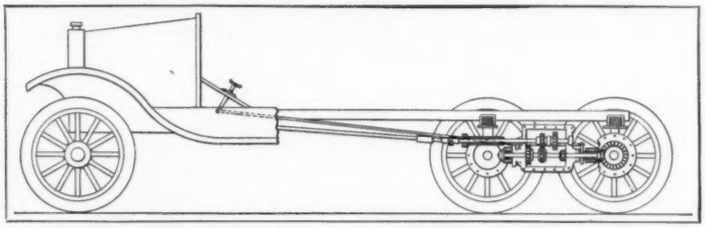
One way to abate it, of course, is to abolish the mud. We fear that it will be some time before our roads are all so built and so maintained, however, that the waters of springtime, and especially the fraction of these waters that results from the thawing of the roadside, will cease to have their accustomed softening effect.

If we can't abolish the mud, the next best thing to do is to insure that it stays where it lies, so far as possible, instead of developing a fond attachment for every car that passes through it. We illustrate four novel devices that are intended to bring about this ideal state of affairs. These were all shown at a recent exhibition of anti-splash apparatus in Paris. The first one recognizes the tendency of the wheel to lift mud and fling it, but tries to regulate that tendency by providing a passageway for the mud to shoot off backward and low, instead of going high and to the sides. Two plates are suspended from the hub in such fashion as to form a narrow channel through which that part of the tire in contact with the road revolves.

A second attachment that works in the same general manner, but that it seems ought to be somewhat more effective, is the low-hung guard shown in our second view. This, however, would be a pretty poor reed on which to lean if the car were to be driven over some of the famous mud-infested roads of America. It wouldn't take much of a rut or hole to snatch the guard clear off.

The photographer assures us that the brush of the third view is designed to revolve with the wheel. If means were offered for attaching it to a dead member of the axle or to some other dead part of the car, we should have more faith in it. As it is, it seems to us that it is open to the same objection as the first scheme, only more so. We cannot help picturing the shower of mud that would strike out in all directions from this brush, once it got thoroughly saturated with earth and water.

The final view is not of a tire of freak shape, as might at first glance appear; the member at the outside is quite separate, being a rubber shield that revolves with the rim. From 3,000 miles away this looks to us like the best of the four models. It seems to us that this shield might well be expected to lay down, gently and without much splutter, the mud that it picks off the wheel.



Vertical longitudinal section of the four-wheel-drive six-wheel truck

The Six-Wheel Truck with Four-Wheel Drive

MANY advantages are added to the use of motor trucks by the recent invention of H. P. Suhl of Kissimmee, Fla. This invention comprises an attachment for converting an ordinary passenger car into a truck of the sort suggested by the above head. As a beginning the device is being manufactured only for use with the small car; but later it will be made for touring cars as well.

The drive attachment constituting the present invention is secured to the rear portion of the car to which it is to be applied. This attachment includes two parallel axles, each having a differential. Bearing members are extended toward each other from the respective casings and are bolted or otherwise secured to the respective ends of a gear casing which is supported between the axles. This casing is braced so as to provide a strong and durable connection between all the parts.

Extending longitudinally and journaled in bearings is a shaft provided at its ends with gears which mesh with the annular gears of the differentials. Fixed to the shaft and housed in the case are other gears arranged so as to secure the desired reductions, when meshed, respectively, with the gears of another set in a sleeve on a second shaft journaled in the top portion of the case and connected by a universal joint to the transmission shaft of the vehicle. A grooved flange or collar is formed on the sleeve, and is engaged by a forked arm formed at one end of a sliding rod. The latter rod extends forward from the gear case and is connected by universal joint to an operating rod which can be connected to a hand lever for shifting gears.

In every instance, when the gears are

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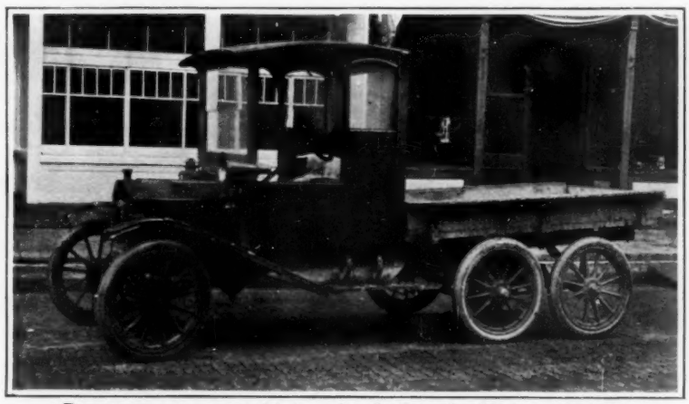
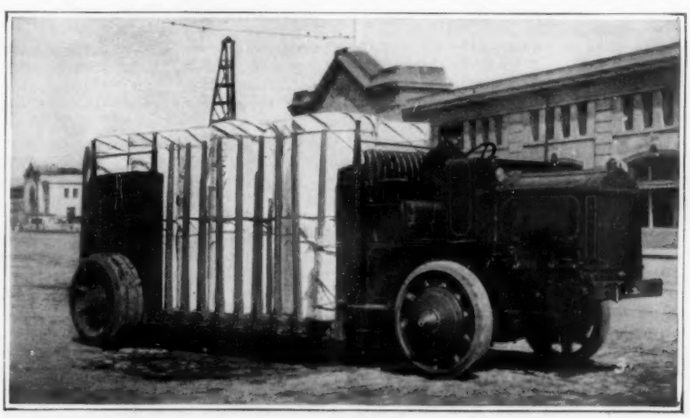


Passenger car converted into a six-wheel truck with four-wheel drive

The Front-Wheel-Drive Truck with Low Clearance

THE truck which we illustrate here might almost qualify for the freak class, so far as appearance goes; but a catalogue of its distinctive features indicates that such classification might be an injustice. The tractive effort is on the narrow front wheels, the model driving with these alone and using the rear wheels for followers only. According to the designer this represents an effort to get back to the principle that ruled when the horse went before the cart. Of less doubtful value is the suspension of the engine from an entirely independent set of springs, intended to remove it from all exposure to road shock. Steering gear and brakes are of the hydraulic type. We are not informed whether the steering is done with the front wheels, or whether these are on a rigid axle to facilitate the front-wheel drive, with the steering left to the following wheels; either arrangement it appears would have its advantages and its drawbacks. The most striking feature is the low-hung body. This is obviously made possible by the peculiar arrangement of the engine suspension in company with the front-wheel-drive scheme. It is, of course, an entirely sensible notion, having done away with the necessity for running a drive shaft down the center of the vehicle at the height of the rear axle, to depress the body to occupy the space thus vacated. Certainly this truck would be the last one in the world to overturn; and if its other novel features will stand the test, it ought to be of much value in many special kinds of service.



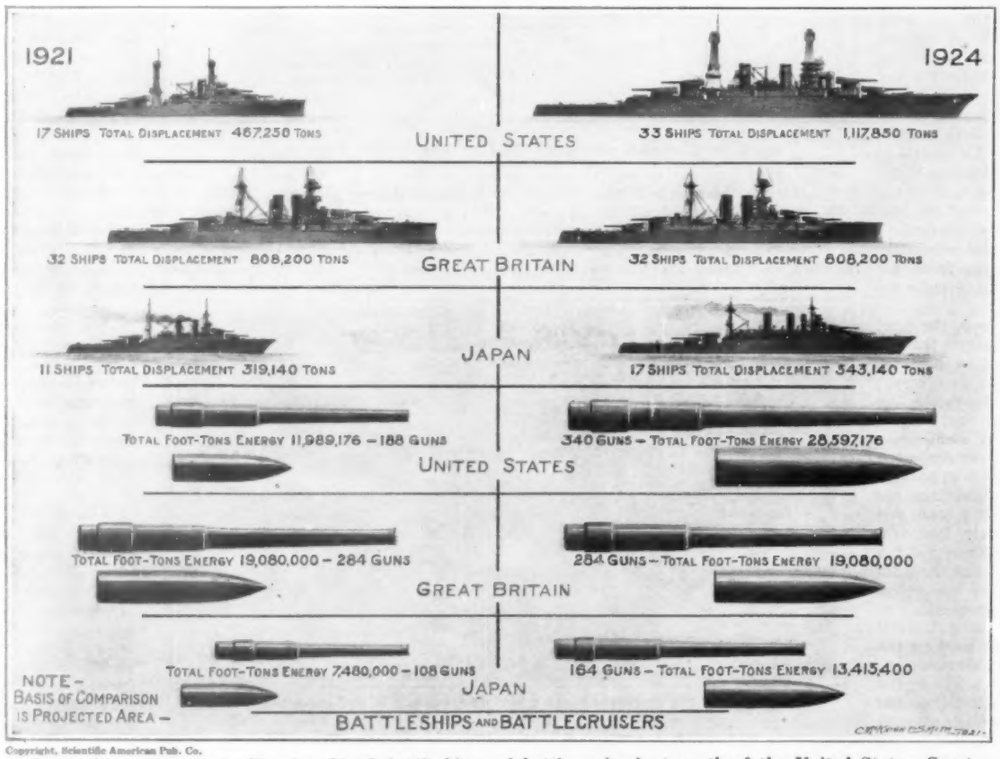
A truck of extraordinary equilibrium and freedom from jar

Leading Navies Compared

First Line Fighting Strength Today and in 1924, When Ships Now Building Will Be in Operation

THE foundation of the strength of a navy is what is known as its "first fighting line," and the backbone of this fighting line is of course its capital ships—battleships and battle-cruisers. Associated with these capital ships in a properly constituted fleet are many other vessels of various types—cruisers, scout-cruisers, destroyers, flotilla leaders and submarines. Our diagrammatic comparisons include only the battleships and battle-cruisers of the United States, Great Britain and Japan. For reasons which we give later, the comparative fighting value of the three navies as shown in this way may be considerably modified by the character and number, in each navy, of smaller but very numerous and highly necessary types of fighting ships. Furthermore, as regards the capital ships alone, it must not be considered that the mere totals of numbers, displacement and gunpower give a literal standard of comparison of the actual efficiency of these fleets. There are many other factors affecting this efficiency, such as the individual size of the ships, their defensive armor, their internal subdivision, their speed, their maneuvering ability, their radius of action, and, lastly, and more important than all the previous considerations put together, the quality of the personnel.

We have heard a great deal of talk recently about the race in armaments, and the impression unfortunately has gone abroad that the three great navies are feverishly building up their fleets in competition with each other to secure the so-called supremacy of the sea. This is not true of one of the great powers, Great Britain. For immediately upon the defeat of Germany and the sinking of the German ships at Scapa Flow, Great Britain, shut down on construction of the battleships and battle-cruisers which she had in hand at the close of the war. Her naval construction has been confined to the completion of some cruisers, scout-cruisers, destroyers and submarines which were so far advanced that it was deemed more economical to complete them than to have them broken up. The only work she continued on capital ships was done in completing the battle-cruiser "Hood," a 42,000-ton, 32-knot ship. She was from sixty to seventy per cent completed at the armistice, and has since been completed and put in commission. There were three sister ships to the "Hood" building at the time of the armistice and these three were broken up. These facts will explain why, in the comparative tables for 1921 and 1924, the same figures occur so far as Great Britain's navy is concerned.



Comparison of capital ship (combined battleship and battle-cruiser) strength of the United States, Great Britain and Japan in 1921 and 1924

Comparison of Battleship Strength

Battleship construction, then, is confined to the United States and Japan. At the present time, including the "Tennessee" which has just been completed and the "California," which is practically completed, our Navy includes 17 battleships of 467,250 tons displacement, which mount 188 big guns of 12-inch caliber and up, whose total muzzle energy is 11,989,176 foot-tons. We have under construction 10 battleships which are in various stages of completion. Four of these are of 32,600 tons displacement, 21 knots' speed and mount eight 16-inch 45-caliber guns, firing a 2,100-pound shell with a muzzle energy of 99,000 foot-tons. These four ships are from thirty-five to eighty-five per cent completed. Also we have six ships under construction, which are of 43,200 tons displacement, 23 knots speed, and are armed with twelve 50-caliber, 16-inch guns, firing a 2,100-pound shell with a muzzle energy of 112,000 foot-tons. These six ships as yet have had relatively little work done upon them. The average of completion of the hulls is about 8 per cent, and the total work on the ships and their equipment is about 12 per cent. The total cost of these six ships when they are completed will be at present prices about $400,000,000.

When the 10 ships have been completed we shall possess 27 battleships with a total displacement of 856,850 tons, mounting among them 292 big guns, the total muzzle energy of which will be 23,221,176 foot-tons. These figures may be compared with those for the British navy which, today and in 1924, will possess 26 ships of 632,700 tons displacement, mounting 240 big guns, with a total muzzle energy of 15,906,000 foot-tons.

Japan at present possesses seven completed battleships of 209,140 tons displacement, mounting 76 guns with a muzzle energy of 5,374,400 foot-tons. She has two battleships under construction, and in 1924 will possess a fleet of nine battleships of 273,140 tons displacement, mounting 92 guns whose total muzzle energy will be 7,070,400 foot-tons. It should be explained here that two battleships which Japan is now building represent all of her actual battleship construction. They form part of a program of four ships, the "Kaga," "Tosa," "Nagato," and "Mutsu." Of these the "Nagato" has been completed and the "Mutsu" is practically completed, and we have included her among the finished ships. The other two, the "Kago" and "Tosa," were begun in January, 1920. These ships are somewhat similar to the four ships of our "Maryland" class. They are of 32,000 tons displacement and mount, like our ships, eight 16-inch, 45-caliber guns. A program of four additional battleships has been projected, but no appropriations have been made and therefore they do not figure in the present comparison.

Comparison of Battle-Cruiser Strength

At the present time the United States possesses no battle-cruisers, although six have been appropriated for and are now under construction. Very little has been done upon them, the keels of three of them not having been laid until toward the end of September last year. At the present writing a rough average of about 5 per cent represents the work done. They will be the largest ships in our own or any other navy, and in common with our new battleships which have been recently illustrated in the columns of the SCIENTIFIC AMERICAN, they will be very handsome ships. The displacement will be 43,500 tons and each will mount eight 50-caliber, 16-inch guns similar to those on our new battleships. Their total displacement will be 261,000 tons, and among them they will mount 48 guns with a combined muzzle energy of 5,376,000 foot-tons. Their length will be 874 feet, and they will have a speed of 33¼ knots, which is higher than that of any existing battle-cruisers.

Great Britain possesses six battle-cruisers fit to lie in the line, led by the "Hood," of 42,000 tons. They have a combined displacement of 175,500 tons and mount 44 guns of 13.5 and 15-inch caliber whose combined muzzle energy is 3,174,000 foot-tons. As Great Britain has no battle-cruisers under construction, her totals for 1924 will be the same. It should be noted that no ship with armor 6 inches in thickness, or less, is reckoned as a battle-cruiser.

Japan evidently sets a high military value upon the battle-cruiser, for it is her intention in the future to build a battle-cruiser for every battleship that she sets afloat. At present she has four completed battle-cruisers, the well-known ships of the "Kongo" class, with a combined displacement of 110,000 tons, mounting among them thirty-two 14-inch, 45-caliber guns, whose total muzzle energy is 2,105,500 tons. She has at present under construction four battle-cruisers, the "Amagi," the "Akagi," the "Atago," and the "Takao." These will evidently be large ships, comparable to our own battle-cruisers. The displacement has been given as 40,000 tons; but in view of the fact that each is to mount ten 50-caliber, 16-inch guns and that they are to have battle-cruiser speed and armor, it is difficult to see how this can be done on such a displacement. If 40,000 tons is the limit, then either the armor or the speed, or both, must have been sacrificed. We understand that the boiler and engine room equipment is for a contract shaft horsepower of 135,000. If so, and the ships are to carry ten 16-inch guns (and we have the very highest authority for the statement that they will), the speed cannot be much over 30 knots. On the other hand, we have heard from rather authoritative quarters that the engine room output will be over 200,000 horsepower. If the latter estimate be correct and the armor plan matches the tremendous battery, these ships cannot be of less than 45,000 tons. Time will show; but it may be taken as certain that the 10-gun battery is correct. As to the progress of these ships, the "Amagi" was begun in September, 1920, the "Akagi" in October, 1920. The keels of the other two ships have not yet been laid. There has been talk of four additional battle-cruisers, but, as in the case of the additional battleships, no authorization or appropriations have been made by the Japanese government, and the whole eight ships may be considered as merely on paper.

Summing up for the three fleets, we find that in 1921 the United States has 17 capital ships, Great Britain

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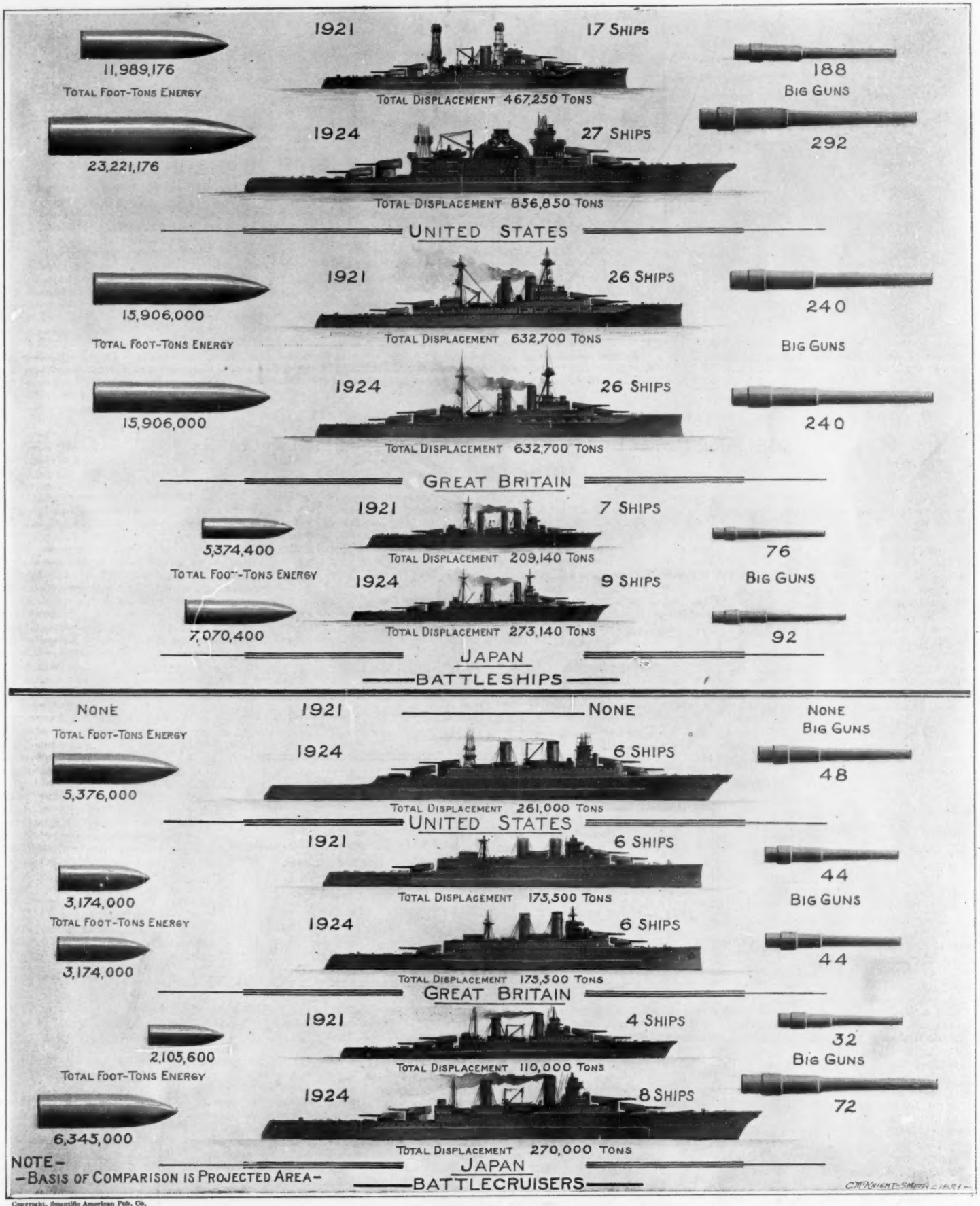
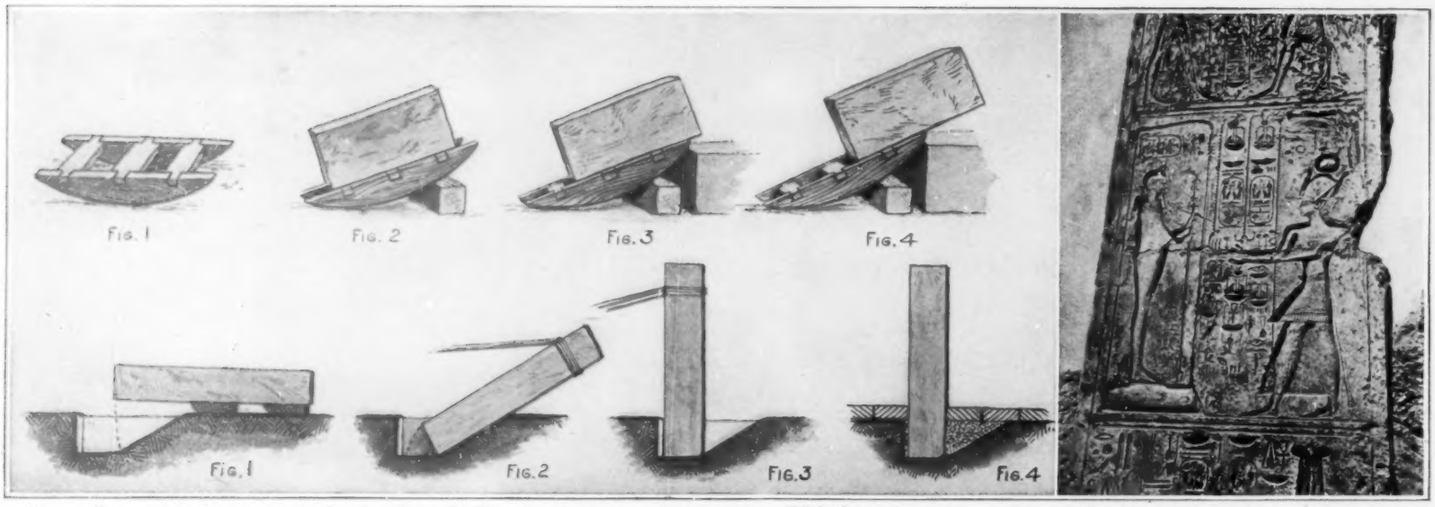


These diagrams show the comparative strength of the United States, Great Britain and Japan in 1921 and 1924. The upper diagrams show battleship strength, the lower, the battle-cruiser strength. Note: This comparison includes only ships built, building, or for which money has been voted



Above: **Four successive stages in the elevation of a big stone by means of the rocker. With the rocker in the position of Fig. 4, it is possible to elevate the lower end to a false-work support higher than the first one, and proceed to the next stage.** *Below:* **Four steps in the erection of a tall column or obelisk with the aid of a trapezoidal shaft.** *Right:* **A detail of Egyptian sculptural ornamentation**

The Engineers of Ancient Egypt

Mechanical Devices Used in Constructing Pyramids and Erecting Obelisks

By G. A. McWilliams

NEW facts of technical interest to all engineers and builders, to say nothing of their appeal to the popular imagination, have been obtained by Dr. Clarence Stanley Fisher to help solve the mystery of how the ancient Egyptians built towering pyramids and huge palaces without the aid of modern lifting equipment. Dr. Fisher is the Egyptologist of the Museum of the University of Pennsylvania. He returned to this country recently after six years at the head of archaeological expeditions to the site of ancient Memphis, near Cairo, and to the royal cemeteries of Gizeh and Denderah.

Among the treasures of ancient craftsmanship brought back by the explorer or now on their way to this country are many ornate stone doorways, constructed of great blocks of stone; carved granite columns nineteen feet high, inlaid with an exquisite enamel or terra cotta known as faience; the floor stones from the dais of the Pharaoh Merneptah, heretofore erroneously known as the ruler of the Exodus, and some huge carved blocks of alabaster.

The last furnish an excellent illustration of the perseverance and ingenuity of the ancients. Three thousand years before Christ, according to Dr. Fisher, they had opened and were working an alabaster quarry at El Amarna, eleven miles from the banks of the Nile and 200 miles above Memphis. To reach this quarry from the river bank it was necessary to build a road over many hills and through deep gullies and valleys.

"The road was constructed originally very much as our roads are built today," says Dr. Fisher. "The right of way was leveled and large stones were packed in. On top of these were placed layers of stones gradually diminishing in size, until the fine ground stone of the surface was placed. This was wetted and pounded, probably by hand, until the top presented a smooth surface.

"Blocks of alabaster weighing many tons were transported over this road on sleds, quite similar in all probability to the rocking-horse devices used for lifting purposes. Hundreds of slaves drew on the ropes attached to the sleds, and the surface of the road was watered to make it slippery. The blocks were then placed on rafts and poled down the river, where they were transferred again to sleds and dragged to the building operation."

By far the greater part of the time spent by Dr. Fisher in Egypt was in the excavation of the Palace of Merneptah. This Pharaoh was the son of Rameses II. The Scriptures have several references to the latter as the king for whom the Israelites in captivity were forced to build a city, hence he had become known as the Pharaoh of the Oppression, and his son as the Pharaoh of the Exodus. Dr. Fisher has corrected this view by finding records showing that Merneptah made war on a tribe, palpably the Israelites, after they had settled in their Promised Land; and as they wandered forty years in the desert before this settlement it is obvious that Merneptah has been misplaced heretofore. Dr. Fisher believes, from other records, that Amenophis IV was the king who drove out the captives, about 130 years before Merneptah's time.

To date the Museum explorers have excavated one entire wing of the latter's palace. They found that this section was evidently the public building, and next year they plan to search for the private palace of the King and Queen. In the building uncovered was the throne room, surrounded by tall pillars supporting the roof. An outer wall beyond these pillars, made of sun-dried brick, was nine feet thick. When these bricks were torn down to obtain the doorways and window sections of carved stone, they were eagerly hauled away by the native farmers to be used as fertilizer, as they contained a large quantity of straw when made, about 3,500 years ago.

Herodotus records that the great pyramid at Gizeh took some forty years to build and required the labor of one hundred thousand workmen, says Dr. Fisher. While these figures may be exaggerated, the labor of constructing such an enormous mass of masonry must have been far greater than we usually conceive. The ancient Egyptians had no elaborate mechanical methods to assist them; only sledges, ropes and unlimited man power which they used in transporting and handling blocks of masonry, aided also by the inclined plane.

Stone was quarried by means of wooden wedges driven in at intervals along the cleavage line. Upon being soaked with water these wedges expanded and split off the stones. We find the same method used well down into Roman times and there are survivals even in modern days. Blocks were shaped and dressed with chisels and drills which were, so far as our evidence goes, of bronze.

The walls of smaller buildings, where the height was not excessive, were constructed by the use of temporary inclined planes of sun-dried bricks or rough rubble masonry erected against the outer face of the wall as the latter progressed. After the stones of the first course were dragged into position, this false structure was built to the height of the stonework already in place. Up these the blocks for the second course were dragged and placed in position, and so on up to the top. The final dressing of the face was begun at the top after the final course was in position, and the temporary structure was removed as this final dressing progressed downward.

In the interior of the building, where columns were used to support the roof, these, when they consisted of drums, were erected in the same way. When, however, they consisted of monoliths a different method was employed. This is very clearly shown in the temples of Kephren and Mycerinus at Gizeh. These were built in connection with the second and third pyramids of the group of which the famous great pyramid is the largest and oldest in date. Here, in the outer and inner halls, positions of the various piers were first marked out on the rock foundation. Then at each place a square shaft was cut with three sides vertical, the fourth side, always on the side from which the stones were to be brought, being cut away to a long slope. The roughly squared blocks for the pillars were then dragged on sledges until their ends were over the shafts and in line with the slope. The outer end of the block was then lifted up with wedges and ropes until it was standing vertically in the hole. The slope not only made this labor easier but made the stone rise into position without any serious jar, which might have fractured it. The shaft was then filled with stones and debris, over which the floor slabs of some finer material were laid.

In all temples the roofs as well as the walls and floors were of stone and these slabs were placed in position before the false work was taken down. All reliefs and other decorations on the walls were done after the masonry was fully in position. In the construction of the great pyramid similar methods were used. Here the whole structure was solid masonry, with the exception of the small burial chambers in the center with the passages leading to them. The burial chamber, which was sometimes below the actual level of the rock surface, was constructed first. In the pyramids

(*Continued on page 140*)

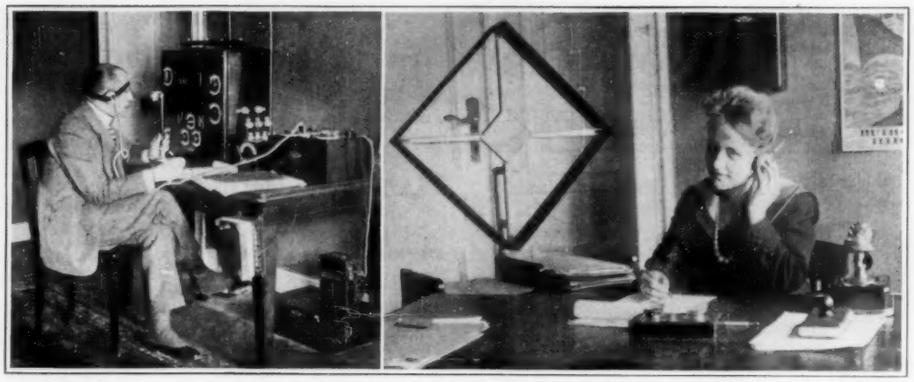
THE old-fashioned answer to the query, "How were the pyramids built?" consisted in vague references to untold millions of slaves, with the implication that the amount and the vastness of work which can be accomplished vary directly as the number of people who can be put to work. The better engineering judgment which our historians possess today makes it clear to them that this is not the case, and that it really is necessary to account for the ability of the Egyptians to perform the tasks which they did perform. Engineering apparatus of some sort they must have had, or the labor of their countless slaves could not have been sufficiently concentrated to become effective. Dr. Fisher's theories, set forth in this article, are the latest and we believe the most plausible suggestion to be put forward.—THE EDITOR.

Making Radio Commonplace

GERMANY has been forging ahead in radio. Indeed, it is Germany's intention to make radio commonplace, and the work is already well under way. The Berliner can receive the news of the day, stock reports, shipping items and other important bits of information in his home or office at certain times of the day. Most important of all, these radio reports are in real understandable German, and not in the dots and dashes of the Morse telegraph code. They are sent out by special radio telephone stations operated by government and private enterprise alike and reaching all parts of the municipality.

Today the German Post Office, which controls telegraph and telephone lines, has five wireless telephone stations in operation. A news service is also functioning between Berlin and other industrial centers. For instance, Berlin and the Ruhr coal fields are kept in close touch with each other by means of wireless telephone service. Then there are two private radio companies which operate news services.

By tuning in for different wave lengths, the Berliner can cut in on any desired news service which may be sending out reports at that moment. And with a knowledge of the Morse code, the Berliner can copy messages emanating from the powerful radio telegraph stations of Germany and other European countries. The apparatus installed in homes, factories and offices is made as simple as possible so as to give complete satisfaction in the hands of the average person. Instead of a lofty antenna, a simple loop is employed. Thus the entire installation can be mounted on an ordinary desk as pictured herewith.—By *Alfred Longville.*



At Left: Telephoning the news of the day to the radio telephone news service subscribers. *At Right:* A fair Berliner receiving the radio telephone news by means of a loop receiving set mounted on her flat-top desk.

Graphic proof of how Berlin is putting the radio telephone to practical use

A Giant Among Giant Freight Terminals

TO Chicago belongs the distinction of having the largest freight terminal in the world—the mammoth building recently completed for the Pennsylvania Railroad. This freight house covers a whole city block, is five stories high and measures 745 feet by 420 feet in plan. It not only offers every facility for the rapid handling of freight, but presents a most striking architectural appearance with its heavy buttresses, walls and arched openings and a massive tower 180 feet high at one end. This tower contains a huge water tank and a clock with 16 foot dials.

The building consists of a structural steel framework encased in concrete, making it fireproof, and with exterior walls of red brick trimmed with colored terra cotta. The ground floor is occupied entirely by tracks, nineteen in all, and trucking platforms. Fourteen of these tracks are in the main building, two each in the wings at the sides which provide covered driveways at the second floor level, and one outside the building at the east side. Between tracks the concrete platforms are 5 feet 4 inches wide. They have an average total length of 800 feet since they extend out from the south end of the building for a considerable distance. The track floor has a capacity of 375 cars a day.

The freight taken from or to be loaded into cars is assembled at the second floor level where driveways are provided at each side of the building, and two at about the center of the structure with a width of 72 feet. These latter driveways divide the structure into the inbound houses 171 feet wide on one side, and the outbound freight house on the opposite side with a width of 100 feet. This floor is divided into sections about 200 feet long by transverse fire walls.

Access to the driveways is gained from the street viaducts, which are on about the same level as the second floor. The freight elevators to handle goods between various floors have platforms 9 feet by 17 feet and are enclosed in fireproof shafts with 8-foot doors at ends. Thirty-one such elevators are in operation at the present time and provisions have been made for eighteen additional ones. Two large automobile elevators with 10 by 24 foot platforms are located near the south end of the building.

This magnificent freight station is a part of the new Union Station plan, now well under way, and which will involve an outlay of about $75,000,000. The freight station alone and as it now stands cost $4,000,000.—By *Robt. H. Moulton.*

Huge freight station recently completed in Chicago. This building is five stories high and measures 745 by 420 feet in plan

A Mighty Map

THE indisputable fact of being the largest relief map ever constructed alone challenges popular interest, but the supreme triumph of molding the world in miniature on a steel chart lends scientific emphasis to an achievement jointly shared by the U. S. Shipping Board and the Navy Department. The map of cast steel construction, recently completed, is 42 feet long and 15 feet wide, and weighs two tons, with a one-ton pedestal. The immense profile was designed by H. Lawson Guppy under the direction of the Shipping Board. The uniqueness and magnitude of the product should serve to fulfil the purpose for which it was originally planned, namely, that of informing and concentrating public opinion of the necessity of upbuilding an American merchant marine.

The structural features of the mighty map, as interesting as they are in their entirety by reason of the composite dimensions of the map and its steel formation, offer additional interest when analyzed in details. Land and sea are portrayed with respect to the physical and climatic conditions of the different zones of the universe. The great waste areas of the Arctic circle as well as the shadowless waters of equatorial seas are denoted by pigments of varying hues. Built in sections—twenty-six, all told—the enormous profile map is a veritable geography of the world, and school children who loathe the subject of geography as bound within the pages of a book would doubtless be fascinated with this description of the surface of the earth and its inhabitants wrought in steel. The topography, verdure, climate of all lands are discernible, while water-enveloped areas are painted in colors so as to identify the temperature, velocity, direction of ocean currents, as well as the course of trade and merchant marine routes.

The actual construction of the steel chart embraced a series of steps. The impressions were made from wax patterns which were cast in a sand flask filled with sand imported from the Catskill Mountains. The modeling of the patterns was of such a character as to render it imperative to project the edges beyond their real limits, in order that relief work on adjoining panels should match when the facings were laid off. The latter was machined to a fineness of one one-hundredth of an inch.

The boiler shop coöperated in producing an angle iron easel capable of supporting the twenty-six panels and when in a hanging position giving the realistic effects of a huge picture. Six weeks were required to construct the map, which is composed of an aluminum of such fine consistency as to take the smallest impression. This veritable geography of steel was first assigned for exhibition at the National Merchant Marine Week in Chicago, after which it will be detailed for a five-year tour of the United States. Its immediate mission of stimulating the claims for an enlarged merchant marine once completed, the product wrought in steel will have a permanent location in the Smithsonian Institution.—By *S. R. Winters.*

Officers of the U. S. Shipping Board and Navy Department inspecting the huge relief map made for the Smithsonian Institution

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

This receptacle under the theatre seat has a number of advantages over the usual wire loop

An Individual Check Room

A DEVICE, which can be attached to the underside of chairs in theaters and other public places, will hold parcels, wraps and hats, and serves the purpose of an individual check room. The receptacle is made of wire and strong cloth and will support 75 pounds in weight. The advantages of this attachment over the old single wire, which could be used only for a man's hat, may be at once appreciated, especially by the ladies. Several theaters in New York have been equipped with this convenient and useful device.

A Folding Boat for the Sportsman

OF folding boats, there is no end. Just now Germany appears to be passing through an epidemic of folding boats, and we have the accompanying photograph to add to our published collection. The boat shown is typical of the many excellent designs that have come to our attention, and certainly there is a genuine demand for such craft. This boat may be folded together and carried in a handbag. It has strong boardwalls which are provided with joints and folds between the light ribs. The weight of the boat is 26 pounds. The invention, in this instance, also includes a collapsible mast and compact sail which may be used when desired.

A folding boat that can be carried in a handbag when completely folded

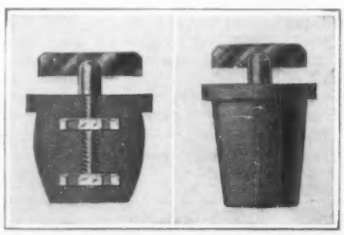
A New Stainless and Flame-Resisting Steel

A NEW steel of striking properties has recently been perfected by a large American steel company. It is not only a new stainless steel, claimed as superior to the widely-known regular stainless steel, but it is also non-magnetic and acid resisting. But its most sticking and probably valuable commercial feature of quality is its flame-resisting power. When attached by the oxy-acetylene flame it requires 20 times as long to melt a hole through as to melt one through ordinary steels. Because of this it is expected that an extensive use for it will be in vaults and safes to insure greater protection from safe-cracking and burglary.

The new steel's composition is not yet made public but it has been developed as a result of a study of steels covering a period of a year or more, originally with a view of producing a steel that could be forged, rolled or sheared in thicknesses of 0.01 inch to 1 inch or more; that would offer maximum resistance to attacks by oxy-acetylene flame; that could be machined as well as capable of the drilling in it of holes.

None of these aims has been realized. It is non-magnetic, rustless in water, fruit acids and glacial acetic acid which is a distinguishing quality as compared with other steels. It is also untouched by 20 per cent or 10 per cent sulfuric acid, 32 per cent nitric acid and by 10 per cent by hydrochloric acid. There is a probability that acid containers or carboys will be made of it successfully instead of glass as at present, insuring a safe shipping carrier and uncontaminated acids.

An unusual property is that it has extraordinarily high reduction of area and elongation at temperatures which could burn anything but high speed steels.



Sectional and exterior views of the expanding stopper and how it functions

A Contracting and Expanding Stopper for Bottles

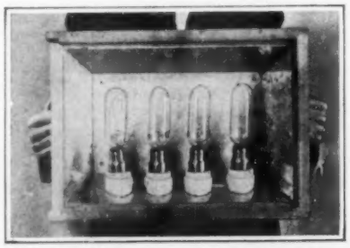
AN interesting device for hermetically sealing bottles after being opened is being marketed by a New York concern. This device is a stopper of pure rubber molded around a screw traveling within two washers, which are firmly embedded and keyed in the rubber. The screw is swiveled in the lower washer to turn without engaging the thread. As the screw is turned to the right the upper washer is brought closer to the lower one, thus expanding the rubber in between so as to enlarge the diameter. The reverse movement forces the washers apart, elongates the rubber, and positive contraction is provided. Thus it is possible to seal hermetically a bottle without the tendency of the stopper to adhere to the neck of the bottle. A twist of the handle to the left draws the walls of the stopper away from the bottle, permitting easy removal.

A Thread Holder that Saves Tangles and Temper

AN ingenious little novelty in the shape of a thread holder has found its way into shops for women. It is a patented mechanical device which holds a spool of thread so that it can be pinned to the sewer's blouse, always ready with a supply of thread to be pulled off. It is light in weight, and the pin for fastening is small so that injury from constant pinning is prevented.

A Portable Light for the Photographer

A POWERFUL portable light and reflector for illuminating objects to be photographed has been developed by a New York commercial photographer. As will be noted in the accompanying illustration, this new device consists of an open box-like arrangement, shaped like a large roasting pan, and containing a number of lamps. The box is lined with aluminum which acts as a reflector for four concentrated filament, 350-watt, nitrogen-filled lamps, which are wired to any standard lighting circuit. The device is provided with two handles, as shown, for holding it near the object to be photographed. Furthermore, it is provided with a sliding cover which protects the lamps from breakage while being transported.



A New York commercial photographer has developed this useful portable lamp

Hydrogen Alarm for Submarines

AFTER having discarded about a dozen instruments as unsuitable for detecting the presence of hydrogen in submarines, the Gas Chemistry Section of the United States Bureau of Standards has developed a new instrument which overcomes the objections of earlier designs. The device, a description of which is being withheld from the public, has been given practical service at the New York Navy Yard and has been tentatively adopted for use by the Navy Department. The severe requirements to which such an instrument is subjected in submarine service made the rôle of the inventor a peculiarly difficult one, and the design accepted necessarily sacrificed some of the advantages outstanding in its predecessors.

An Indicator for the Electric Iron

AN indicator attachment for electric irons tells whether the electric current is on or off, a fact which cannot always be quickly told without some special means. The indicator works upon the solenoid principle, and the condition of the iron is easily told by looking at the small black indicating pointer which travels up if the current is on, and remains at the *off* point if current is off.

A thread holder which holds the spool pinned to the sewer's blouse

Recent Patent Decisions

The Measure of Diligence. — Appeal from a decision of an Assistant Commissioner of Patents in an interference proceeding awarding priority to senior party, Backdahl. The invention relates to mandrels or cores for the formation and curing of pneumatic tires. Counts 1, 3 and 6 are sufficiently illustrative of the six counts of the issue, and are here reproduced:

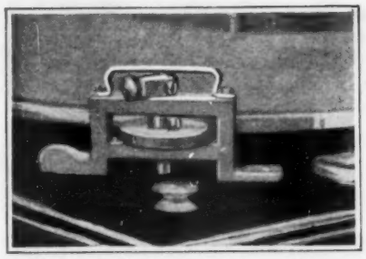
1. A fluid-tight, hollow, stretchable, metallic mandrel.

3. A tire-making mandrel, comprising a fluid-tight, hollow, lead annulus, provided with an inlet for introducing an expanding fluid.

6. A tire-making mandrel, comprising an inner rigid metallic ring adapted to fit between the halves of a tire mold, and an outer, annular, hollow, lead mandrel body thereon, provided with a fluid inlet pipe extending through said ring.

The defendant is restricted to his filing date of December 4, 1915, for conception, disclosure and reduction to practice. The Patent Office Tribunal found that the plaintiff conceived and disclosed the invention September 7, 1915. From that time to June, 1916, the plaintiff was endeavoring to evolve a fluid-tight and expansible lead core,

A glance at the indicator tells whether the current is on or off the electric iron



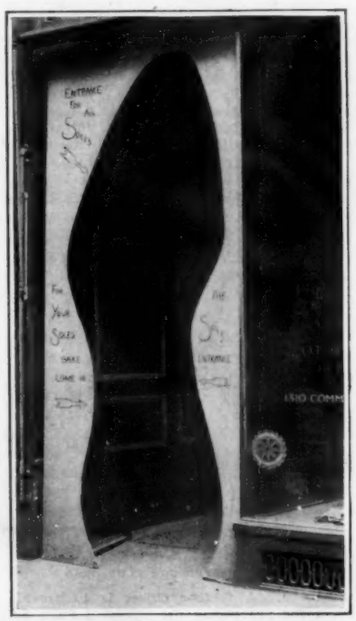
Device which is mounted on phonograph and serves to resharpen steel needles

adapted to produce a cord tire as well as a fabric tire. A core that would produce either would be within the issue. The application drawings were commenced the latter part of May and completed late in June, when they were turned over to a patent attorney who was very busy at the time and later took a vacation extending over a month. There was further activity on the part of the plaintiff in August, 1916, and the application was filed on November 8th.

It is held that where, as here, it clearly appears that the party first to conceive the invention was in good faith engaged in perfecting it at the time his adversary entered the field, that party should not be deprived of the fruits of his discovery because his efforts were not as successful as he hoped they would be, unless further tests were so unnecessary as to constitute evidence of negligence or bad faith.

An inventor is to be commended rather than condemned for taking reasonable time to perfect his invention, to prevent the Patent Office from being overloaded with applications for patents for crude and incomplete devices.

The court holds that Gammeter, the plaintiff, was not lacking in diligence. The evidence shows that he was diligent, and yet there is no arbitrary rule or standard by which diligence may be measured and each case must be considered and decided in the light of surrounding circumstances. The court is fully convinced of the good faith of Gammeter, the plaintiff, and therefore it reverses the decision of the Assistant Patent Commissioner, and awards priority to the plaintiff.—*Gammeter v. Backdahl. U. S. C. C. A of D. C.*



Copyright, Keystone View Co.

Shaped like the sole of a shoe, this entrance is bound to attract attention

A Tiny Grindstone for Repointing Steel Phonograph Needles

THAT highly fertile field for the inventive mind, the phonograph industry, has now introduced a new device in the form of a steel needle pointer. This device, which is shown in the accompanying illustration, makes an ordinary needle play over one hundred times according to the claims of the inventor.

In brief, the new device consists of a stand which is mounted on the usual phonograph in such a way that its rubber-faced wheel may be brought into contact with the rim of the phonograph turntable. The device has a hole which takes the standard steel needle and holds it in such a way that the point comes in contact with a cylinder of abrasive material. Thus while the needle is being held in place, the abrasive face, revolving constantly, sharpens the point of the needle.

A ruler on the under side of which are fastened nine blotters for the sake of convenience

A Ruler That Has a Blotter

SIMPLE, true, but highly useful is the device shown in the accompanying illustration. It consists of a ruler in the form of a strip of wood, on the under side of which are mounted nine sheets of blotting paper. This arrangement has evidently come from some inventive mind that has grown tired of searching for a blotter after using pen and ink. Essentially, the device is intended for blotting signatures, but it is a combination blotter and ruler as well.

Making Toothbrush Bristles Removable

THERE is some doubt in the minds of certain authorities as to whether we have not been making a huge mistake in the use of a brush for the teeth. They are advocating a soft cloth, and to this end one manufacturer has perfected individual paper napkins for the teeth. The bone of contention seems to be in the fact that a toothbrush will and does collect bacteria, if not properly looked after. To overcome this objection, however, a brush has been perfected which permits the entire removal of the bristle section. It can be plunged into boiling water any time necessity demands. Made entirely of metal, boiling will not injure either bristle section or the balance of the brush.

An Entrance That Speaks for Itself

AN ingenious mind conceived the idea shown in the accompanying illustration. Here is an entrance to a shoe-repairing shop, which has been cut out in the form of a shoe sole. Made of wall board, it is inexpensive and simple to construct, yet its advertising effect is well nigh incalculable, especially on New York's busy thoroughfare, lower Broadway, where thousands of passers-by can always be attracted by something out of the ordinary. And the same ingenious mind has livened the "sole" entrance with several slogans, as shown.

A Reamer for the Hard-Worked Pipe

THERE has recently been perfected a simple device for cleaning the bowl of any pipe. This device, which is shown in the accompanying illustration, consists of a springy loop member on the legs of which scraper members are hinged. To clean the bowl of a pipe, the scraper members are introduced and pushed down. Automatically, these scraper members adjust themselves to the sides of the bowl, and the turning of the loop member or handle scrapes the bowl clean in a minimum of time and effort.

Potash

WE had this subject very much before us during the war, and it was a poorly informed person indeed who could not make a show of intelligent discussion of the sources of potash, the costs of production, and the probabilities of the American industry becoming an adequate source of supply against the domestic demand, and of its resisting the efforts of Germany to make a post-war reconquest of this department of world economy. But today we are very apt to forget that the problem exists or ever existed. Mr. Skerrett's discussion of it in the current issue of the SCIENTIFIC AMERICAN MONTHLY for February emphasizes the "picayune scale" on which we have been searching for this indispensable raw material, and emits a timely word of warning against future repetition of the mistakes of the past.

The Radio Typewriter

ONE of the recent developments in wireless telegraphy was demonstrated in Great Britain a couple of months ago. This consists in the automatic printing of wireless messages in Roman type. If it can be done over the wires, it can obviously be done without them; but the technique is of necessity somewhat different. Those interested in the subject will find the apparatus described in the February number of the SCIENTIFIC AMERICAN MONTHLY. The system makes use of a special perforator the tape from which is passed through a special typewriter and converted into readable messages.

Removing the bristles from a recently-introduced toothbrush for a thorough cleansing

A New Rail Joint That Speeds Up Work

A SPECIAL rail joint devised to help speed up the work of moving rails ahead on a pipe-laying job in Denver has fully demonstrated its usefulness. So much good time was taken up in assembling and disconnecting the regular splice bars, bolts and nuts that the need for a special joint was keenly felt. The result has been that a joint has been planned that can be disconnected by a few blows of a sledge hammer. A clamp, a steel wedge and steel tapered pins are the essentials of the new arrangement. One side of the clamp is so shaped as to fit firmly up against the side of the rail. The other side of the clamp, which stands several inches from the rail, is held by the tapered steel pins. Under the pins and between the clamp and the rail is driven a steel wedge that tightens the joint. Only three lengths of rails, which are spiked to 8- by 16-inch timbers, are used. The pipe-layer keeps moving the rails ahead. This new joint was used successfully in laying a new concrete water supply conduit for Denver.

A push into the bowl of the pipe and a few turns scrapes the bowl

New Alloy for Watches

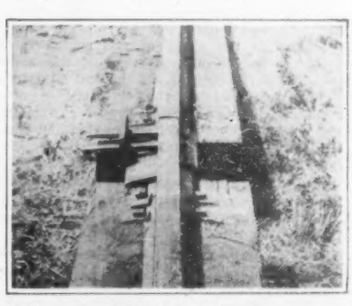
A DISCOVERY described as being capable of revolutionizing the watchmaking industry has just been announced by Mr. G. E. Guillaume, Director of the International Bureau of Weights and Measures. A successful method of regulation, remedying the variations in time of a watch due to the expansion and contraction of its parts caused by variations of temperature, is the result of Mr. Guillaume's invention.

This so-called "secondary error" has always been one of the great obstacles in the attainment of perfection and precision in the watchmaking industry, and if this difficulty is overcome the watchmaking industry should receive considerable impetus, owing principally to the simplifying of the process of regulation. The current issue of the SCIENTIFIC AMERICAN MONTHLY deals at length with this subject.

The chief feature of Mr. Guillaume's new process is a change in the alloy used in the compensating parts. The minimum expansion of nickel steel was found to be increased by the addition of 12 per cent of chrome as well as a very small quantity of tungsten, manganese, or carbon. By mounting a spiral of this steel-nickel-chrome alloy in the watch, according to Mr. Guillaume's announcement, the problem of compensation has been solved and the "secondary error" removed.

Machining Material Glued with Casein Glue

CASEIN glue joints may be safely machined within four hours after gluing and before the glue becomes so hard as to injure the cutting edges of tools. Three casein glues investigated at the U. S. Forest Products Laboratory all have a shearing strength of approximately 1,000 pounds per square inch within two hours after spreading and within four hours it reaches approximately 1,200 pounds. The maximum strength of the joints and hardness of the glue are not reached, however, within the four hours.



This new rail joint, intended for temporary track, may be disconnected by a few blows of a sledge hammer

Recently Patented Inventions

Brief Descriptions of Recently Patented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

MEANS FOR STABILIZING FLYING MACHINES.—S. DE SANTIS, Naples, Italy. The invention relates to stabilizing wings of flying machines, having a pivotal connection between the wings and body, a weighted controlling lever at the center of gravity of the body, a plurality of guides and cables secured to the controlling lever, said cables passing around the guides then crossed and secured to the wings.

METHOD FOR PROPULSION OF SHIPS, BOATS AND FLYING MACHINES.—S. V. CORTES, 268 Avenida del Brazil, Valparaiso, Chile. The invention relates to propulsion mechanism of the rotating blade or paddle wheel type, mounted on a vertical, horizantal or inclined shaft, at the sides, bottom, bow or stern of a vessel. The object is to obtain a greater efficiency of propulsion than has been attained with submerged paddle wheels and boxes, together with a lifting or sustaining effort which is especially useful when the system is mounted on submarine vessels, airships and airplanes.

METAL CONSTRUCTION.—E. E. BROWN, and D. J. MOONEY, c/o Steel Wing Co., Ltd., 48a Gillingham St., London, S. W., England. This invention relates more particularly to the construction of spars, an object being to provide a metal bar structure which combines strength with lightness of weight, and which is especially adapted for use as a spar in wings, fuselages, struts, and the like in the construction of airplanes.

Pertaining to Apparel

HOSE SUPPORTER.—C. J. HAUSEN, 368 W. 50th St., New York, N. Y. The object of the invention is to provide a hose support of simple construction attached to a corset and arranged to securely grip the hose, but insure perfect freedom to the wearer's body and limbs without producing undue strain on the hose. Another object is to permit the user to quickly engage or detach the support.

Electrical Devices

GEAR SHIFT. — J. O'D. SHEPHERD, 29 Abernarle Ave., Atlanta, Ga. The particular object of the invention is to provide an electrically operated gear shift in which the shifting in sequence or progression is automatic, but capable of alteration in the progression by manually operated control; a further object is to provide an electrically operated gear shift which will be, to a large extent, automatic, causing the gears to shift in the normal progression thereof, the initial operation being brought about by a manually operated clutch lever which closes the electric circuits.

GAS BATTERY.—P. A. EMANUEL, Aiken, S. C. The foremost object of the invention is to provide a battery of the Grove type, the principal departure being that the platinum electrodes of the Grove cell are substituted by electrodes of a cheaper and different material. A further object is to provide a gas cell having a specially prepared iron anode and cathode, suitably separated to segregate the dissimilar electrolytes in which the two electrodes are respectively immensed.

AUTOMATIC ELECTRIC FUEL MIXTURE REGULATOR.—A. A. LOETSCHER, 28 E. High St., Detroit, Mich. This invention has for its object to provide an automatic electric fuel mixture regulator, for internal combustion engines, under the control of and responsive to the speed of the engine to effectively vary the proportion of the hydrocarbon and the air whereby the fuel mixture or charge delivered to the cylinders is accurately proportioned and of proper composition as to provide for perfect combustion and maximum power at all engine speeds.

Of Interest to Farmers

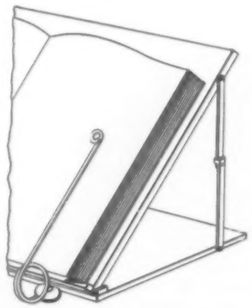
CHURN.—P. R. THIBAULT, Box 183, St. Ignace, Mich. This invention relates more particularly to a type of churn employing a stationary body and a rotating paddle, the body having double walls forming a liquid cooling chamber there between, the object being the provision of certain refinements as regards both the construction of the body and the paddle calculated to promote more ready manufacture and more efficient results.

HOE.—R. N. MOORE, Box 23, Mitchell, Iowa. The invention more particularly relates to an attachment adapted to be applied to the standard makes of wheeled hoes. It is distinguished by an arrangement whereby one knife may be adjusted transversely and is rockable relatively to the other knife and independently of the guard; the guard is so formed that it constitutes a colter to cut hard ground in advance of the front knife, the guard has a relation to the rear knife to prevent plants from being damaged by the same.

SHOCKING ATTACHMENT FOR HARVESTERS.—J. C. RADER, Cando, N. D. The invention relates to machines for shocking wheat and other grain. One of the principal objects is to provide a shocking machine adapted to be attached to a harvester in place of the original bundle carrier, for receiving the bundles from the harvester, tying them together and forming the shock, and then depositing them on the ground butt end first, the machine moving away from the shock without disturbing the position of the latter

Of General Interest

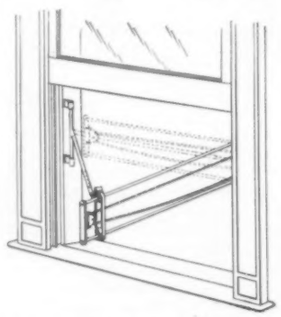
BOOK REST.—H. W. BROMLEY, Wilmore, Ky. Among the objects of the invention is to provide a simple, efficient and inexpensive device for securing a book in open position against the rest, and to so construct the parts



A VIEW IN SIDE ELEVATION

as to facilitate the removal of the book or the turning of the pages, the hands being free for making notes. The device permits of a comfortable position in reading, with a saving of eye strain, and an entire freedom of limbs, not possible when the book has to be held in the hands.

COMPENSATING SAFETY CLOTHESLINE HANGER.—A. HEYMAN and C. C. VERVOORT, 152 Newell St., Brooklyn, N. Y. The invention relates particularly to a type of hanger which may be withdrawn within a window, so that the clothes may be conveniently hung thereon. Among the objects is to provide a



VIEW SHOWING THE APPLICATION OF HANGER TO A WINDOW

clothesline support of simple and rugged construction which is adapted to be positioned outside of the window when not in use, the support may be readily adjusted to windows of different sizes, and is arranged to prevent the possibility of collapsing when in use.

FLYTRAP.—T. J. MCKAY, P. O. Box 1522, Atlanta, Ga. The invention has reference to a fly trap that is of a most sanitary nature. Among the objects is to provide a device having a body or main receptacle of such material as to be easily and thoroughly sterilized and from which practically all of the parts are removable. Another object is to provide a trap that is so constructed as to provide for the utmost attraction for luring the insects thereto.

BRUSH.—J. BERGSTEN, 1324 Edwards Ave., Bronx, New York. The object of the invention is to provide a brush arranged to permit of readily and quickly assembling the parts and to allow of conveniently replacing a worn brush body by a new one Another object

A PLAN VIEW OF THE BRUSH

is to form a brush body of an inexpensive material by using the heretofore wasted bark of the balsa (Ochroma lagopus).

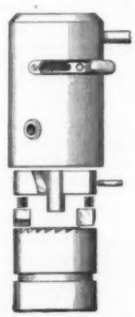
ICE CREAM CUTTER.—I. SEITZMAN, 774 New Jersey Ave., Brooklyn, N. Y. An object of the invention is to provide means for simultaneously cutting a large number of bricks into pieces of uniform or any desired size. A further object is to provide a machine which may be operated by hand power, foot power or engine power, such machine including the construction of a tray on which the bricks are supported and cut.

MANUFACTURE OF SHOES.—H. W. STEDLER, Lossnitz Erzgebirge, Germany. The invention relates to a method of making shoes having a previously formed tip, an insole, and an upper, comprising an abutment member on the outer edge of the upper, positioning the upper by pressing said abutment member inwardly over the bottom of the insole, securing the upper and insole together, and removing the abutment.

BAG.—J. STEMBER, 36 E. 22nd St., New York, N. Y. The object of the invention is to provide a hand bag, traveling bag or like article having a metallic frame, whereby a secret pocket for containing bills or valuable papers is provided to prevent unauthorized persons gaining access to such secret pocket while the bag is in the possession of the owner.

Hardware and Tools

ATTACHMENT FOR PNEUMATIC TOOLS.—A. E. MOORE, 377 Quincy St., Brooklyn, N. Y. An object of the invention is to produce an attachment for use in connection with air driven hammers or other pneumatic tools



THE TOOL DISASSEMBLED PARTS DISPLAYED AS REMOVED FROM SLEEVE CASING

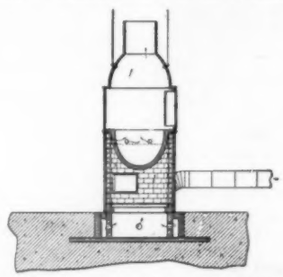
used in connection with all manners of steel structure work, for driving rivets and executing other work necessitating a hammering tool, or which may be used for rotating drills, reamers and similar machine tools.

KITCHEN KNIFE.—R. L. MOFFETT, 4618 N. Racine Ave., Chicago, Ill. An object of the invention is to provide a kitchen knife with means for holding an ordinary safety razor blade firmly in such a position that one edge of the blade serves as a cutting edge for fruit, vegetables and the like, while the other edge is sheathed to insure the back edge of the device being blunt.

TIRE CHAIN TOOL.—S. G. DOOLITTLE, 7 Burnes St., New Haven, Conn. The invention has particular reference to a hand operated tool for opening and closing the hooks of chains commonly used for non-skid purposes on automobile wheels. Among the objects is to provide peculiarly shaped jaw members so designed as to reduce to a minimum the likelihood of slipping of the tool in the opening of a chain link.

Heating and Lighting

SOFT METAL FURNACE.—J. B. MCCLAIN, 893 Fourth Ave., Brooklyn, N. Y. The invention especially relates to furnaces for melting certain ores or metals that are not overly refractory. Among the objects is to provide a furnace having peculiar merit for the melting of aluminum, babbitt metal, solder or



A VERTICAL SECTION OF THE FURNACE

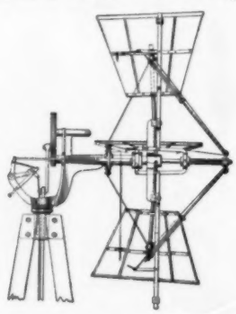
other soft metals, the flames and other products of combustion being caused to pass through or over the bowl. In this device the operator has access to the metal, and means are provided for pouring the molten metal directly from the bottom of the bowl.

STEAM BOILER.—W. F. SCHANZLIN, 232 S. Jameson Ave., Lima, O. The primary object of the invention is to construct a water tube boiler in such manner that the water tubes are subjected to the greatest possible amount of heat. A further object is to construct the water tubes in such manner that the cross-over tubes are entirely eliminated, thus doing away with dead air space, and consequent loss of heat. A still further object is to provide a plurality of upper drums and means for securing them together.

Machines and Mechanical Devices

STAMPING MACHINE.—J. L. JACOBS, 324 Lafayette St., New York, N. Y. The invention relates more particularly to the stamping of ribbons, and its object is to provide a machine by means of which gold (liquid or ink) may be used in applying marks to ribbons, and which will reproduce the mark in a clear cut impression, which may be subjected to extremely rough usage without detrimental effects.

WINDMILL.—O. OLSSON, Ord, Neb. An object of the invention is to provide means for constructing and connecting the blades or vanes of a windmill with the operating



A VIEW IN SIDE ELEVATION WITH CERTAIN BLADES REMOVED FOR CLEARNESS

mechanism. A further object is to provide means for preventing the windmill from becoming forced out of operation by a sudden blast of air. The windmill is so mounted as to obviate the necessity for a regulating vane, and is entirely automatic in its action.

(*Continued on page 138*)

A Giant Job of Underpinning

(*Continued from page 124*)

In places where derrick stone was used there was no attempt to insert mortar of any kind.

The building was put up at a cost of $24,000,000 and required twenty years to build. Only the fact of its slow growth prevented its serious settlement and cracking, according to present day engineering opinion. Its tremendous weight was applied so slowly and so uniformly to the inadequate foundations that there was time to accommodate them to the load. On one corner—the northeast—the foundations rested on solid rock. But this rock surface shelves away toward the northwest corner and the entire south side of the building. Above it is a layer of disintegrated mica schist, and above that a hard packed gravel and sand formation capable of supporting considerable weight.

Here was a problem almost without precedent in a building of this size. It was obvious that if work progressed along the lines originally planned, to expose the foundations, they would crumble into dust and there would be serious and perhaps dangerous settlement. There was nothing to do but to abandon the initial plans and set about making new ones. These had to provide not only for complete replacement of the defective rubble walls by brick or concrete masonry, but also an entirely new method of roof construction for the subway station. The first plan of roof construction called for a roof of steel transverse girders carried by steel longitudinal girders between the subway tracks, these in turn resting on cylindrical piers sunk as open wells. It was considered that because of the initial disturbance necessary to the foundations, such a roof would be inadequate and its use might be followed by destructive settlements.

Early in 1916 the Department of Transit approved the new plan and operation was started. The entire roof of the subway was built on the ground surface, through or adjoining the foundations, and simultaneously with or immediately following the reconstruction of the old foundations. The support of the building on the soil was temporarily increased by the placing of reinforced concrete or steel roof girders along the sides of and as part of the new foundations, in order to carry their load between the intertrack subway walls to be built later. The subway roof, consisting of a close assembling of girders, thus formed the lowest course of the building, but did not take any of the weight at this time, as will be seen.

The operations of rebuilding foundation walls and building the subway roof and walls are more easily described separately, although the work was necessarily interdependent. For the foundation work, pits were sunk on both sides of the wall at each point of attack, six feet long in the direction of the wall and four feet wide. In the solid masonry or brick work above the rubble foundations, narrow slots were cut. The pits were sunk to a point nineteen inches below the level of the subway roof, and then their floors were planked with a heavy mattress. On these mattresses were placed jacking drums, four to a pit. Two pairs of fifteen-inch I-beams were then inserted as needles through the slots in the masonry above, their ends bearing on the drums. Each of these four drums contained a hundred-ton hydraulic jack, and by means of these half the estimated load of the six-foot section of foundation was taken up.

The next step was to remove the wall between the pits. The plank mattress was then extended to close the aperture, and on top of it was laid a grill of 15-inch I-beams. Four other posts were placed on this grillage and wedged against the needle beams, and the hydraulic jacks were removed. The beam grill was then concreted, forming the base for new foundation walls. Thus two partial shifts of weight had been accomplished, one to temporary foundations on undisturbed earth, the second to the new foundations. Eventually the entire weight went to these new foundations.

The entire 700-foot length of the subway section was reconstructed in these short six-foot sections. As a rule, men worked in gangs of five. Many sections were rebuilt simultaneously, but they were so widely scattered that there was never any possibility of more than local disturbance to the weight. When, by this means, the length of an entire roof girder section had been completed, the concrete or steel beams were placed parallel to the wall. When the foundations of the entire wall had been reconstructed one-fourth of the area and tonnage of the building rested on the roof of the subway, which in turn rested on the solid, undisturbed earth.

The operation of underpinning the roof, with its weight of one hundred thousand tons, was a marvelous demonstration of the accuracy of modern engineering methods. Sheeted pits were dug under the ends of the completed roof girders, one by one, and widely separated, as in the case of the temporary pits for the foundations. To reach the points where these pits were to begin, pits were first dug in the City Hall basement, and tunnels were run in under the girder ends. It was possible to use gangs here of but four men, who sheeted and dug out the pits, which range from four by five to five by eight feet. The dirt was lifted in pails and small sheet iron barrels on a chain block supported on a beam over the top of the pit, and wheeled through the tunnel to the basement floor. As a rule these pits were sunk to an average of seven feet below the groundwater point, but some of them went down to ten or twelve feet. This bottom level is five to eighteen feet above the rock.

Fifteen-inch steel-pipe piles were now driven down the pits to the rock. Muck was removed from the pipe every four or five feet by filling three or four feet of water into it, sinking a three-inch air pipe with 100 pounds pressure and turning on the blast. When the pipe struck rock bottom it was filled with concrete. The smaller pits contained four such pipe piles, and the larger ones as many as fifteen. When they had been driven the pits were filled with concrete and grouted or bricked up under the roof girders. These concrete pits, built separately and at widely distant points, form the walls of the subway. Yet when all had been built and the core of earth had been removed, the piers were in perfect alinement.

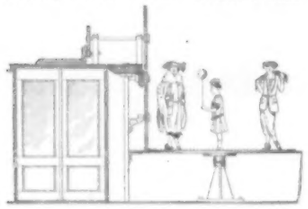
The removal of the core meant the second complete shift of the weight. Up to this time it had been on the foundations of which the roof girders are a part, but these rested on solid earth and the piers had not taken the load. This was the final test of the whole long, tedious operation. As the work progressed in sinking piers, every possible precaution was taken. Thousands of tests were made of the bearing power of separate piers, by hydraulic testing apparatus. Engineers were employed who did nothing but examine the walls of City Hall minutely, day by day. Every crack was marked so that at the slightest sign of spreading it might be discovered.

Excavation was started at the south end and carried through in three operations. The first lift was just enough for a shallow heading, high enough to give working room to remove the temporary grills, which had been separated from the roof girders and foundations above by a tar-paper joint. But in order to bring down this grill it was necessary in some instances to use air hammers or light charges of dynamite. With this down, excavation was resumed down to the ground water level. A third lift took out all the earth in the core down to sub-

RECENTLY PATENTED INVENTIONS

(*Continued from page 136*)

DISPLAY DEVICE.—J. D. NOBLE, c/o J. Evans, 705 Carroll St., Brooklyn, N. Y. An object of the invention is to construct a display device which will act as an attractive advertising medium. The invention aims to



A PARTLY SECTIONAL FRONT VIEW OF A FORM OF THE DEVICE.

provide a regulator particularly applicable for use in connection with revolving doors which will prevent of a too rapid rotation of the door and at the same time permit a utilizing of the energy now wasted in a door of this type.

Medical Devices

REDPAN.—K. E. BLUM, 220 Broadway, New York, N. Y. This invention relates to hospital appliances. It is one of the primary objects to produce a device of this character which is capable of being readily taken apart in order that the contents may be conveniently emptied, and the pan properly cleaned and kept in a sanitary condition.

Musical Devices

PEDAL OPERATED DRUM-BEATER AND CYMBAL-SOUNDER.—R. C. SCHEURER and H. A. LATHROP, 508 Summit Ave., West Hoboken, N. J. The invention relates to pedal-operated devices for beating a bass drum and sounding cymbals in an orchestra, the device may be readily attached and detached, and securely adjusted; being pedal-operated, it leaves the hands free to beat the small drum or play other instruments.

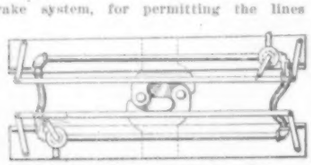
Prime Movers and Their Accessories

APPARATUS FOR RECLAIMING OIL.—J. R. MILLER, 4026 N. Minister St., Pittsburgh, Pa. The object of this invention is to provide an apparatus by means of which lubricating oil, such as oil drained from the crank cases of internal combustion engines, may be reclaimed and made fit for use. A further object is to provide an apparatus for coagulating the dirt, driving off the volatile hydrocarbons with which the oil is contaminated, and preventing the formation of emulsions during the process.

STARTING DEVICE FOR EXPLOSIVE ENGINES.—A. WEISS, 405 E. 82nd St., New York, N. Y. The invention aims to provide a crank by means of which the crankshaft of an engine may be turned over at will, but should the engine back-fire, resulting in a reversal in the direction of rotation of the crankshaft, the crank will be thrown automatically out of engagement with the shaft and consequently no injury could result to the person operating the same.

Railways and Their Accessories

TRAIN LINE CONNECTION.—A. LAF. BARRINGER, Statesville, N. C. The invention has for its object to provide mechanism in connection with the train line of an air-brake system, for permitting the lines on



SHOWING A TOP PLAN VIEW.

cars to be connected at either side of the cars without the necessity for entering between the cars, and for providing a double connection, either of which may be used, the connection being shiftable from the car or from the side of the car.

AUTOMATIC TRAIN STOP.—T. T. CHALONER, 510 W. 47th St., New York, N. Y. The invention relates particularly to train stops adapted to be attached to a locomotive or other part of the train, and arranged to engage and actuate danger arms positioned along the track whereby the stop mechanism will be operated for opening the air-brake system of the train when the danger arm has been engaged.

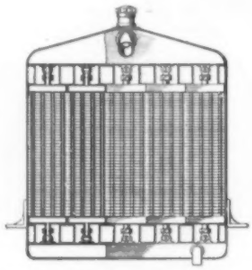
RAILWAY TIE AND FASTENER.—H. A. CLARK, Box 1257, Detroit, Mich. A purpose of the invention is to provide a railway tie comprising a pair of plastic blocks spaced apart and formed with sockets, in opposite ends thereof, and fasteners of simple and durable construction which effectively support the rails and their loads, securely hold the rails against spreading, and withstand the action of the elements.

Pertaining to Vehicles

DECK COVERING FOR VEHICLES.—M. FULLER, 9 W. Chamberlain St., Chattanooga, Tenn. The invention relates generally to vehicle tops and more particularly to a deck or covering for commercial and pleasure vehicles, the object being the provision of a deck structure which will be rigid, strong and light in weight with permanent waterproof qualities.

POWER PLANT FOR VEHICLES.—P. C. LEIDICH, 4236 Pane St., Frankfort, Philadelphia, Pa. The invention relates to power plants especially adapted for, but not necessarily limited to, use in connection with automobiles, the general object is to provide a power unit in which compressed air is employed as the motive fluid, the unit being so designed that the storage tank can be charged from an external source or from one or more pumps installed on the automobile.

RADIATOR.—L. LOUGHLIN, 112 Jefferson Ave., Jersey City, N. J. The invention relates to radiators for motor vehicles. The primary object is to provide a radiator which com-



A VERTICAL SECTIONAL VIEW OF A RADIATOR AS INVENTED.

prises a plurality of individual sections, any one of which may be removed for the purpose of repair without rendering the radiator wholly inoperative.

THAWING MEANS FOR RADIATORS.—B. M. COBE, 711 W. 180th St., New York, N. Y. The object of the invention is to provide thawing means arranged to permit of quickly thawing out a frozen radiator on starting the internal combustion engine of an automobile, airplane or the like. Another object is to provide a device which can be readily applied to various makes of radiators without undue alteration in the construction, or in the operating of the engine. The device can be readily attached or detached.

TRANSMISSION MECHANISM FOR AUTOMOBILE VEHICLES HAVING WHEELS AND ENDLESS TRUCKS.—E. RIMAILHO, 12 Rue de la Rochefoucauld, Paris, France. This invention has for its object a transmission mechanism which permits of obtaining in an automobile vehicle an alteration from the progression by wheels to the progression by endless tracks or vice versa. This device is particularly intended for use where it is necessary sometimes to travel by road or across fields and over rough ground.

Designs

DESIGN FOR A DOLL.—E. EY, 158 Fifth Ave., Woodside, L. I., N. Y.

DESIGN FOR AN EMBLEM, BROOCH, BUTTON, FOB OR SIMILAR ARTICLE.—J. B. CURRAN, Jr., 2433 Valentine Ave., Bronx, New York.

grade. All that remained to be done of the major operation was to build the six-inch sub-base and the 12-inch top floor.

Throughout the entire acre of masonry shifted in this feat of engineering, but one crack was found, and that was found to be a purely local disturbance that might have happened anyhow. Yet this crack calls attention to one of the most remarkable features of the work. City Hall is equipped with four corner towers, each of which contains a circular stairway from the street floor to the sixth. These are considered more or less of an engineering marvel. Each stairway consists of huge blocks of granite, one end of each cut at a sharp angle and cantilevered into the masonry wall. There is no other support than the angle and, of course, the rigidity imparted by the structure as a whole. The crack was in the wall supporting one of these blocks. It was in the two circular stairways included in the underpinning, that trouble was expected.

To avoid it variations of the plan described were used under these towers, and under the south branch of the Market Street Subway. The masonry under the south tower was in fairly good condition. A steel plate girder was laid in a trench parallel to the foundation, virtually at its base, and at the ceiling level of the subway. A concrete buttress to the wall, bonded into the old masonry, was then cast above and around this girder. This increased the area of foundation on the ground, compensating for a drift then cut through the wall behind the girder and buttress. A second girder was put through this drift and brought to bear on a mattress of concrete on the soil below. When the entire set of transverse girders had been placed by this method, drifts were cut under their ends for longitudinal girders on the line of the future subway walls. Pits for the wall piers were then sunk one by one under these longitudinal girders, and concreted. A variation of this method was used on the other tower.

For the Market Street Subway undercut it was necessary to reconstruct the concrete floor of this old subway in order to make of it a bridge to cross the new subway. Drifts were cut through on the line of the new subway walls, six feet high, and timbered as they proceeded. When completed they were concreted solidly between side forms, thus forming a deep concrete girder under the old floor. The new steel construction was then put in place one track at a time, by night work, when traffic was light or could be diverted to a single track. Then piers were built as in the other operations under the main girders.

What added to the difficulty of the entire operation was the fact that the subway section consisted almost exclusively of a station, and not straight tunnel work. There are three inner and two outer walls to the construction, and eight entrance and exit passages. Some of these are from the interior courtyard of the City Hall, and some from the outer plaza. During the early months of the operation a flurry of local interest was caused by the supposed discovery of a hot well under City Hall. Engineers found the ground water unusually warm, and once in a while steam was emitted. Various tests were made to determine whence this came, but unsuccessfully. Aniline dyes were placed in the sumps of large office buildings nearby, but were not traced to the warm water.

It is estimated that it will be five years before this station is in use, although there is little to be done to it now but to lay tiles and tracks. The final system will include a delivery loop running east and west from Broad Street on Arch, one block north of City Hall, south on Eighth and Sixteenth Streets (Broad is the equivalent of Fourteenth in the numerical order) and connecting on Locust, two and a half blocks south of the hall. Two sections totaling about a thousand feet have been constructed of the subway on Arch and Locust Streets.

When originally planned it was estimated that the system would cost $56,000,000. That sum, of course, is now far from adequate. One estimate places it at $100,000,000 and others still higher. This is for the entire system, including two elevated lines connecting with the northern end of the subway, and the Frankford elevated, connecting with the Market Street elevated at Front Street and running into the northeastern section of the city. This latter line is complete except for some station work and equipment.

The subway work, particularly around City Hall, was accomplished with remarkably little disturbance to foot traffic and almost none to vehicles. An occasional derrick rising between green-painted board fences gave little idea of the intricate operation going on underneath. On the surface the dynamiting in the final stages was little more than a dull rumble. This had to be used with the utmost delicacy and accuracy. In some places there were huge blocks of concrete that had been laid as temporary foundations, within the earth core, and these were broken up with the explosive.

Why Balloons Bounce Off Clouds

(*Continued from page 125*)

fined to balloons, and that is not felt by the pilot of a plane.

The cloud obstacle which confronts lighter-than-air craft has an exactly opposite effect upon machines that are heavier than air. The effect, however, is much less noticeable in the latter. When an airplane encounters the cool air of the clouds, there is an increase in the lifting efficiency of the wings because of the greater density of the cool and damp air. Also, when an airplane emerges above a cloud into the warm layer of air where the density is less there is a tendency for the craft to sink, but this is usually counteracted by speed. Many airplanes can climb at a fairly steep angle with a speed of sixty miles per hour. Whenever a heavier-than-air craft starts downward from above the clouds, and strikes the warm layer of air it would likewise sink readily and easily through, which is exactly opposite the effect created by this warm air upon balloons.

The Vacuum Tube as an Engineering Problem

(*Continued from page 125*)

In the case of the tube, he does not usually know the indications of trouble and the various limits for the tube, simply because as yet the tube is a comparatively new device.

The user of a kilowatt rotary converter knows that he can probably get 2 kilowatts out of the machine for a short time, but he also knows that certain things are sure to happen if he persists in doing it continuously. The fact that he can get 2 kilowatts from his machine does not induce him or the manufacturer to rate it at 2 kilowatts because they both know its limitations.

It is the same with a vacuum tube. The maker may give it a rating of 50 watts and it may have been carefully tested so that it is known that under the specified conditions it will deliver that energy continuously through a life of so many hours. If, however, when using it in the regular way, the filament and plate voltage are both raised, it may be possible to obtain 100 watts. Yet it is not right to call this a 100-watt tube, because in so raising its output some factor, usually the life, will be unduly affected.

As another example, take the case of an abnormally large input for a normal output, mentioned in the case of the rotary converter. Such a condition is common in the operation of a power tube and will have bad results if not corrected. When, in the future, knowledge

relative to the vacuum tube is greater and more widely distributed, the condition described above will be understood when it appears and the cause remedied to the same extent as in a rotary converter.

It will be seen, therefore, that improvements in the performance of tubes and vacuum tube apparatus is dependent upon three factors, which, at the *present time*, probably are of the following order of importance:

(1) Engineering development of fundamentals which have already been discovered or worked out by scientists or physicists.

(2) Better understanding by the users relative to the limitations and possibilities and the engineering principles involved.

(3) Discovery of new scientific facts.

As the art develops the third factor becomes increasingly important and undoubtedly will sooner or later head the list.

Pumping Coal from Mine to Seaboard

(*Continued from page 126*)

machine, which separates the impurities.

The coal which is reduced to a pulverized consistency is then shot into the pipe line and carried to the cities by means of the power from pumps placed every few miles. The process of mixing pulverized coal with water and pumping the mixture through pipes was invented by Wallace C. Andrews in 1883 and patented by him in 1891. He built experimental pipe lines to demonstrate the practicability of the scheme. It has already been demonstrated that mixtures of 50 per cent by weight of coal and water can be successfully pumped; and not only that, but the mixture may be allowed to stand in the pipes for more than 24 hours and pumping be resumed without trouble. The assertion is made that mixtures of 75 per cent by weight of coal and 25 per cent of water can be successfully pumped, and it will probably be found that mixtures with even higher percentage of coal can be sent through the pipe line.

On the first page of this issue is shown a set of diagrams of the apparatus of Mr. Bolton's system. It has already been demonstrated in Germany and Great Britain, and in this country, that the most economical way to burn coal is as a powder, as witness the immense blowers and automatic stokers which use this kind of coal in all of our great cities. In such conditions it is easily handled and is under perfect control, and practically no smoke results. Blown into the highly heated combustion chamber, each particle of coal explodes and becomes a gas. The coal in this condition makes the next best fuel to natural gas. The induction of it under the proper air current is automatic, causing a great saving of labor. The burning value of the coal is enhanced about twenty per cent. The present wasteful methods are soon to be replaced by this method of pulverizing coal and the resulting saving and cheap price of coal to the consumer will do away with the fear of car shortages and other things which have heretofore held back the supply when most needed.

How We Think

(*Continued from page 128*)

ment, the neurone fibers develop a protecting sheath. The precise function of this structure has still to be demonstrated. It is believed that it may aid the transmission of nervous impulse along the fiber.

Observations show that while the other layers of the cortex early reach their complete development, the pyramidal layers continue to increase in thickness until later in life, and do so at a very slow rate. This may possibly be in order to accommodate the growth of the pyramidal neurones. These continue to develop throughout the life of the individual, as experience with the environment stimulates them to perfect their interconnections. Hence, we may say, that, here, as in the case of the animals lower than man, it is the number and condition of growth of the pyramidal neurones which determines the status of mental capability.

Further light upon the relations of the pyramidal neurones to intelligence has been shed by the study of the brains of the idiotic, imbecile, and feeble-minded. It has been shown that the pyramidal neurones of idiots are poorly formed, undersized, and, more important still, possess very few fibers. In extreme cases no fibers at all were present. This means that correlations, connections, unions, assemblages of ideas, memories, sensations, etc., are impossible where there exist no physical connections between the multitudinous pyramidal neurones.

In conclusion it might be said that it is this inability of feeble-minded parents to transmit to their offspring anything but imperfect intellectual equipment, which in no slight measure is menacing many of our urban communities, as well as filling our asylums and jails with the criminally insane to be harbored at state expense. The fact that the number of pyramidal neurones is fixed before birth has an immense sociological significance, a significance, which, as has been said, is often a tragic one!

The Six-Wheel Truck with Four-Wheel Drive

(*Continued from page 129*)

meshed properly motion is transmitted to the shaft and through the gears to the two differentials so that both pairs of drive wheels will have uniform speed. The ground friction of the vehicle is thus greatly increased, with a corresponding rise in the carrying capacity. Importance is attached to the means for connecting the two axles of the attachment, for the reason that this is of such nature as to hold them firm against all relative motion save in the vertical plane.

Truck users find that this outfit will go wherever a team will go, and no ground seems too soft or too uneven for it to negotiate. One of the demonstration stunts was the crossing of heavy marsh land while loaded with a miscellaneous assortment of farm tools, wire, fence posts, etc. Even ditches at which the ordinary truck balked were crossed without apparent extra effort.

The manufacturers insist that this is the only four-wheel-drive, six-wheel truck that has been successful. It is inexpensive and will be of special value to farmers, since it is particularly adapted to the hauling of milk, cheese, feed, livestock, and in general to any use where mixed heavy and light hauling is required of a single installation.

Leading Navies Compared

(*Continued from page 130*)

32, and Japan 11. If the present shipbuilding programs are carried out, by the year 1924 the United States will possess 33 capital ships, Great Britain 32, and Japan 17.

Just here we draw attention to the fact that the great size and extremely heavy armament of our new ships would give us in 1924 a great preponderance of power over the British fleet, even if judged merely on the totals of displacement and gun energy. Thus, while we shall have about the same number of ships, 33, and the British, 32, the displacement of these ships will be 1,117,850 tons as against 808,200 tons, and the total gun energy will be 28,597,176 foot-tons for our capital ships, as against 19,080,000 foot-tons for the British ships. In numbers, displacement and gun power, our capital ship fleet will be considerably more than double the strength of the Japa-

nese fleet, as is shown by our comparative diagram.

There is another consideration, however, which should modify any estimate of the comparative power of our own and the British fleet in 1924, and, to a certain extent, today—and this is that, while the British capital ships with the exception of the "Hood," do not embody the extremely valuable lessons which they learned from the Battle of Jutland, our own ships will embody this knowledge. The "Hood" was built subsequently to the Battle of Jutland, and she is considered by the British to be greatly superior in offensive and defensive qualities, even ton for even ton, to any of the existing capital ships of her fleet. The Jutland lessons, as regards hull protection, et cetera, were only applied in a patchwork way to a few of the existing British battleships and cruisers for the first line; but all of the priceless information gained from that battle was given freely by the British Admiralty to our own Navy Department, which has been free to embody it in our later ships, and most of it, undoubtedly, has been and will be so used. Consequently, in addition to the great preponderance of displacement and gunpower which our new Navy will show, as disclosed on our diagrams, there is a hidden but valuable preponderance of quality due to the incorporation of the rich experience of the war. If Great Britain builds no ships during the next four years, her navy at that date, though large in numbers, will be, all of it, more or less obsolescent, and many of its earlier battleships will be absolutely obsolete.

It is impossible at the present time to make any predictions as to the future composition of the leading navies and their relative strength. In Great Britain and, to some extent, in this country, there is a violent controversy raging as to the value of capital ships. To those of us who are informed and keep in close touch with naval affairs, this controversy has no such great significance as it must seem to have to the average lay mind. Indeed, with the exception of one or two of the older admirals, Lord Fisher and Admiral Sir Percy Scott, who had no active sea duty during the war, the bulk of the attack which is being made upon the battleship in favor of the seaplane and the submarine has been carried on by people outside of the navy, or by men inside and outside the navy who are interested in advancing the cause of the submarine and the seaplane and airship. To our mind nothing has been brought forward which has shaken the position of the capital ship as the foundation of the fighting line of a nation's forces.

Where Our Fleet Is Deficient

We have many times pointed out in these columns that due to the interference of Congress with the plans of the General Board for building up our sea forces, our navy is today, and always has been, poorly balanced. Our navy has always been distinguished for an excess of battleships in comparison with the other types of fighting vessels which are necessary to make up a well-rounded fleet. Today we are over-strong in battleships and destroyers, and we are weak in battle-cruisers, scouts, or "light cruisers" as they are now called, large sea-going cruisers, and flotilla leaders. Our lack of any battle-cruisers in commission today is, of course, the most serious problem of all. Should we find ourselves at war with a navy possessing ships of this type, we should be powerless to maintain our lines of communication with the fighting fleet, or to prevent a wholesale and most disastrous raiding of our mercantile fleet. If the Germans had possessed the true sea-going and sea-fighting spirit, they would have sent their battle-cruisers out onto the seven seas, where they could have remained away from their base for many months, preying upon commerce and replenishing their fuel and stores from captured ships. The allies would have had their own battle-cruisers with which to hunt for these raiders; but since they were of about equal speed, it would have been a long and doubtful chase. In our case, with no battle-cruisers whatsoever, we were without any ship during the war that was able to overtake and engage these powerful vessels with any prospect of success.

We are building ten scouts that will be the fastest and most powerful of their type when they are in commission, but we need more of these. Also, it was proved during the war that for the proper handling of destroyer flotillas, each should have a larger vessel of its own type to act as a flagship. At present we have none of these.

Udoubtedly, at present, the citizens of every nation are in favor of a drastic reduction of naval and military expenditures. This is certainly true of two leading nations, Great Britain and the United States; and some of the leading officials of Japan have expressed themselves as also in favor of a great reduction. In view of this spirit, which is certain to bear some fruit, we suggest that what money is voted for construction should be devoted to filling in the gaps in our navy. We suggest that we should cease for the present the construction of the six big battleships of the "Indiana" type and devote our efforts to completing the battle-cruisers and scouts and building a certain number of flotilla leaders. Lastly, in view of the great importance of aerial observation, we should commence the construction of two large airplane carriers of at least 30 knots' speed. If appropriations for new construction will not cover this, we suggest that it would be a good policy to redesign two of our battle-cruisers as airplane carriers and complete the other four according to the present designs.

The Engineers of Ancient Egypt

(*Continued from page 132*)

of the IVth dynasty this chamber was lined and roofed with fine masonry, and in order that this could be built a great square pit had first to be cut down to the proposed floor level of the chamber, and in this the complete room was built. The pit was then filled in around and above the walls and roof of the chamber with rough masonry. The passages were begun in the same way, and as they sloped upward through the masonry of the upper structure work on them was continued *pari passu* with the building of the pyramid. As pyramids had a height of from 200 to 500 feet the incline used for dragging up the blocks was built around the sides of the pyramid itself, spirally, as we might say. It has been suggested by a St. Louis architect that this slope was actually left in the masonry itself and later filled in after the main mass was completed. Since the pyramids were all faced finally with finer stone, it appears that this casing was placed in position from the apex of the structure downward, and that as it was completed, it concealed the incline and a smoothly finished, sloping face was left behind as the masons worked their way down.

Still another method of lifting described by Dr. Fisher and long known to Egyptologists is the rocker device. One end of this, as shown in the illustration, was tilted down. By means of wedges and levers the block of stone to be lifted was transferred to this end. Levers were then inserted in the other end, which was pressed down by man power until the stone had been lifted as high as possible, when that end was blocked up. It is suggested that a false platform was built to take all or part of the weight of the stone, and it then became an easy matter to elevate the unburdened end of the rocker. Under the whole device was then constructed a false platform, and the process of rocking upward was repeated time and again until the desired height had been reached. While this process entailed an enormous amount of labor, that was a plentiful commodity in Egypt in her days of glory. And the rocker method represented a great saving of material over the inclined plane.

The illustrations fail to indicate the task which is faced by the explorers in their study of ancient Egyptian ruins. For instance, the ground floor of the Palace of Merneptah was found sixteen feet below the surface of the earth at Memphis. Six different strata of occupations were found in the intervening earth. The time of Merneptah is fixed at about 1350 B. C., and as Memphis was founded by Menes about 3,000 B. C., it is believed there are ruins of other palaces below that of Merneptah. But future excavation will be still more difficult, for one foot below the floor level of the present palace is the water line.

Builders and brick makers will be particularly interested in a discovery made by Dr. Fisher in a small tomb at the cemetery of Denderah. The arched entrance to this tomb was made of jointed or dovetailed, sun-dried bricks. What is said to be the oldest man-made arch in the world was discovered some years ago by another Museum explorer in Babylon, far down in the ruins of ancient Nippur, the Biblical Calneh. It is said to have been built about 4500 years B. C. But in this and in all other arches, whether of Egypt or Babylon, the bricks were not jointed. And a curious fact is that search of other tombs failed to reveal any general use of the discovery. It has been only within the last fifty years that the linked brick has come into general use again in building construction.

Industrial Skin Hazards

IT is becoming more and more in evidence that skin diseases of various types are prevalent among workers, and that in many instances these conditions result from the manufacturing procedures in which the worker is engaged. Very little information is available as to the frequency of these diseases, the industrial processes that produce them, the kinds and severity of the skin lesions, the methods of profitable treatment, the methods of protecting the workers against exposure, etc. For this reason a committee has been appointed by the Health Service Section of the National Safety Council to compile all obtainable information of this nature and to make such recommendations as appear to be helpful in the prevention and control of these industrial skin conditions.

This committee will serve as a clearing house for the collection and dissemination of data on the best methods of preventing and controlling skin diseases, and the most satisfactory methods of treatment. Progress has been made in the control of skin conditions in many industries that should be made available to all industry. It is apparent therefore, that any assistance you can render this committee will react to your advantage.

Under "industrial dermatoses" the committee includes any noteworthy abnormality of the skin (hair or nails, etc.) that originated incident to industrial working conditions, or was aggravated by such conditions. This will include such lesions as rashes, eruptions, and inflammatory processes, hypertrophies (thickening or hardening of the skin) from hard use, such as on the hands or on the lips, low grade chronic skin diseases from long exposure to peculiar light rays or from certain heat processes, skin diseases from constant friction or pressure, loss of hair, etc. Properly speaking, most burns are likely to involve the skin, but inasmuch as the common types of burns from fire have been so well studied this committee will not include this particular skin lesion. Such burns as chemical burns, X-ray or radium burns, etc., are however of especial interest.

Exterminating the Fire Rat!

UP until a few years ago, no method had been devised to protect furnace walls from the gnawing teeth of the great heats that modern boilers generate.

The most fire-resistant clays, brick and tile, succumb prematurely to this action, so that boiler plants were forced too frequently into idleness, while the chewed and broken walls of their fire boxes were torn out and replaced by still more food for the fire rat.

To the rectification of these fire clay failures, Johns-Manville has contributed largely, for by research and experiment it has made the science of refractories of practical service to man—an important contribution to conservation and an interesting story as well. The findings are applicable alike to the fire pot in the kitchen stove or to an industrial process of the obscurest sort.

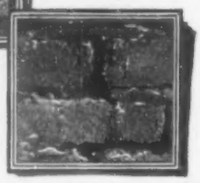
Fire Brick chewed out and cracked after exposure to heat. This means shutting down a boiler for days while new Bricks are set up in place of the old ones. Johns-Manville Heat Treatment reduces this shut-down and replacement expense.

TEMPERATURES run very high in boiler furnaces, sometimes exceeding 3,000 degrees F. Even the best materials commercially usable will stand such heat but temporarily.

Fire Brick, built into walls and archways becomes furnace masonry: which is expected to withstand such heats.

But as soon as the "bond" between the bricks begins to disintegrate, crumble or melt, the life of the fire bricks themselves is immediately threatened.

"Close-up" of fire brick work set up with No. 31 Refractory Cement—Note that the heat has not harmed it—in the least.



"Close-up" of same kind of brick wall set up with fire clay. The fire rat has been at it.

What happens in a boiler fire box

The great weakness, then, in all furnace masonry occurs at these joints between the fire brick. They may disintegrate, due to contraction and expansion, or melt or crumble, due to direct action of the heat.

Any of these reactions removes the fire clay from the brick joints. It is at the open joints thus formed that heat gets in its damage. Concentrating there, its effects pile up as more and more gnawing, either shaling off portions of the brick, deforming it by melting, or permitting the adhesion of clinker—result, an expensive piece of masonry ruined in a few weeks and a boiler idle for repairs.

The Remedy

By ingenious mixtures and treatments of clays and minerals in combination with asbestos, Johns-Manville has devised a series of cements. One general class to be used as binders between fire bricks and another class as over-all surface coatings.

Of great elasticity, these materials accept brick expansion and contraction without damage. They are resistant to high temperatures and retard the adhesion of clinkers. It is this treatment that has improved the life of boiler settings many fold.

View of a boiler furnace, grates removed, treated with Johns-Manville Refractory Cements. This setting will resist heat, prevent premature checking or spalling and will retard the adhesion of clinker.

So successful has Johns-Manville heat treatment been in boiler practice that the application of its materials and principles has extended rapidly in the last few years, and today includes similar treatments for many types of furnaces and processes where high heats are employed.

A list of these materials is given below, together with other heat saving materials that combine to effect the conservation of power, fuel and equipment.

Johns-Manville Refractory Cements: Retort Cement No. 20; Refractory Cements Nos. 31 and 26 for use between bricks; No. 32 for use as coating; Monolithic Refractory Baffle Wall; Aertite Boiler Wall Coating. INSULATIONS: Asbesto-Sponge Felted, 85% Magnesia, Asbestocel, Zero, Anti-Sweat and Ammonia Insulation, Underground Conduit Insulation and Insulating Cements.

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